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SYSTEM OF SOUTHERN SIERRAS POWER CO.
Part II—Transmission and Distribution System.
BY R. W. VAN NORDEN.

STRUCTURES FOR THE DISTRIBUTION SYSTEM.
BY B. A. ETCHEVERRY.

SIPHON SPILLWAYS.
BY C. F. ADAMS.

CO-OPERATION IN THE CORPORATION.
BY M. H. GREGG.

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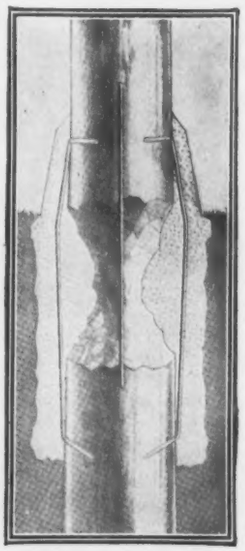

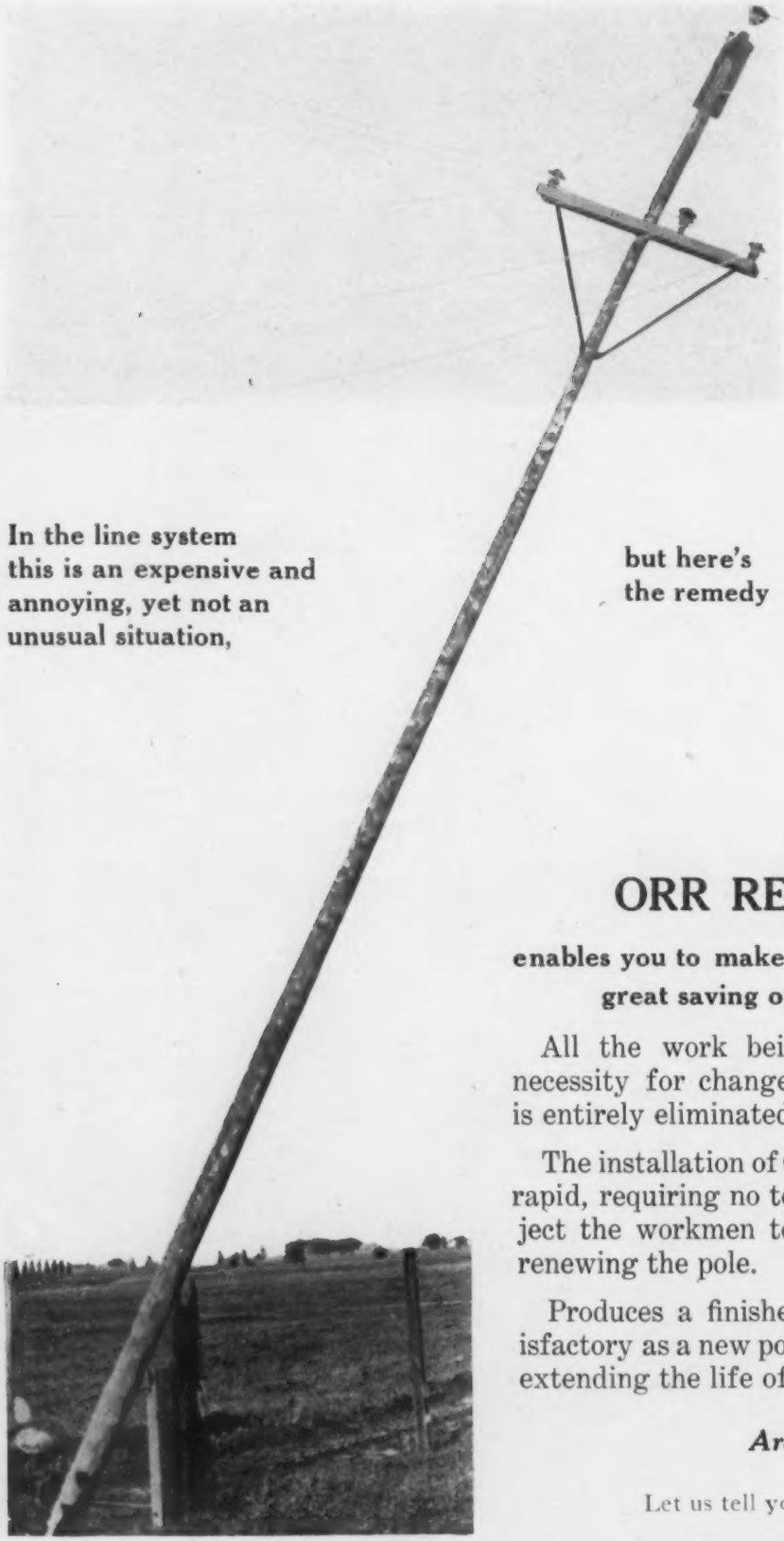

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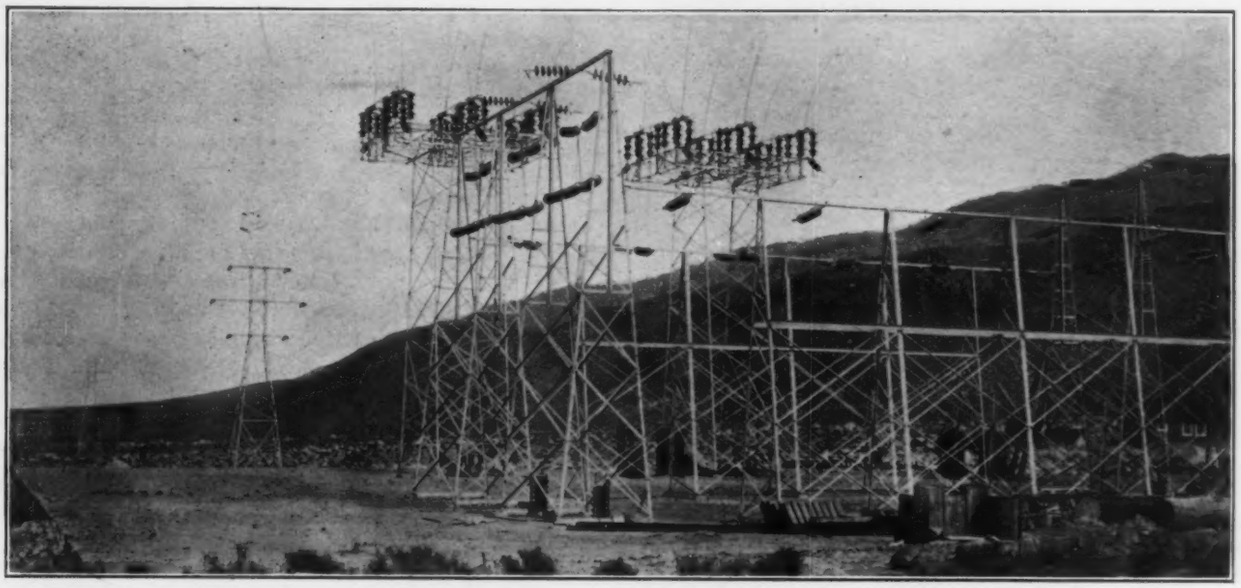
SYSTEM OF SOUTHERN SIERRAS POWER COMPANY

PART II — TRANSMISSION AND DISTRIBUTION SYSTEM

BY RUDOLPH W. VAN NORDEN.[1]



Control Station Near Mouth of Bishop Creek Canyon, and Commencement of Transmission to San Bernardino.

There are a number of features in this division of the newer system which undoubtedly represent modern design and construction in its most advanced form and as such are well worth a close study by engineers and operators. At least seven features, all of them radical steps in the forward progress of the art of transmission and distribution, but taken only after a thorough study of the conditions necessary to make such a transmission commercially possible are noticeable. And an individual study of details in which every feature seems to have been carefully balanced to determine, not the best common practice to follow, but a proper practice to obtain the expected future results, is in evidence. These features which make this system of particular interest are: an advance in the design of steel transmission towers suitable for the highest transmission voltages together with a number of special designs for a particular service; the extreme voltage of transmission; a "wishbone" type of steel pole for single extra high voltage circuits; an uncommonly long uninterrupted transmission; the consistent use, on both high and low voltage circuits of substations without housing of any sort, and finally, the use on practically all circuits whose voltage is above 6600, of air-break horn type circuit breakers.

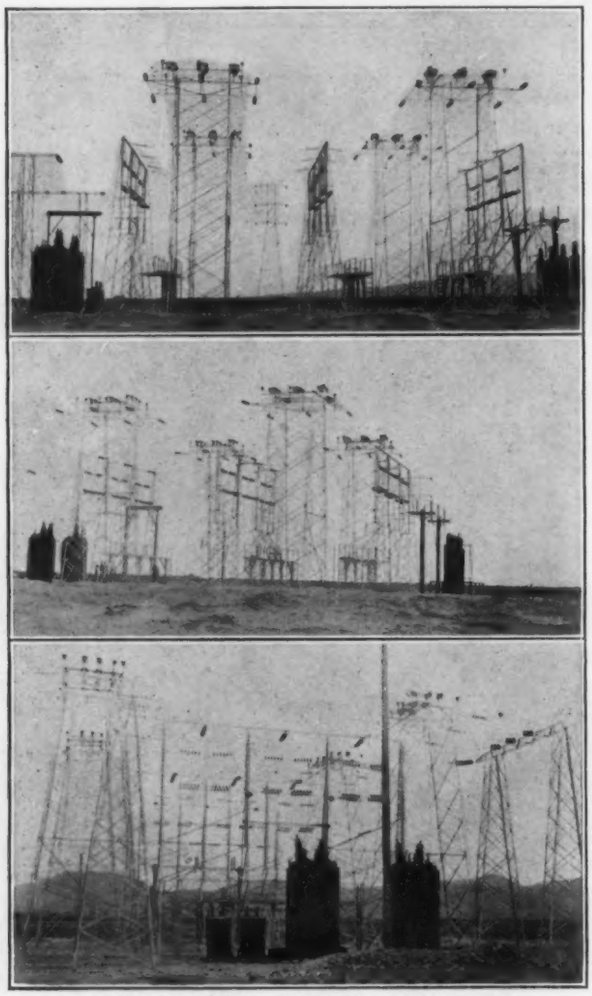
The transmission system may be divided into four distinct parts; single circuits carried on wishbone steel poles, connecting the various power houses with the high tension control station; the high tension transmission line of two circuits carried on steel tower structures; the secondary 33,000 volt transmission lines carried on either lattice steel or wooden poles; and the telephone line on wooden poles paralleling the main transmission.

General Description of Southern Sierras System.

The control station is placed on high ground, about one-half mile below the outlet of Bishop Creek canyon and only a short distance from power house No. 5, and transmission lines from all directions may approach without obstruction. This station, as its name implies, controls the circuits which feed the transmission lines by a series of circuit-breakers and disconnectors and it is the point of commencement of the

[1]Fellow A. I. E. E., Member A. S. C. E.

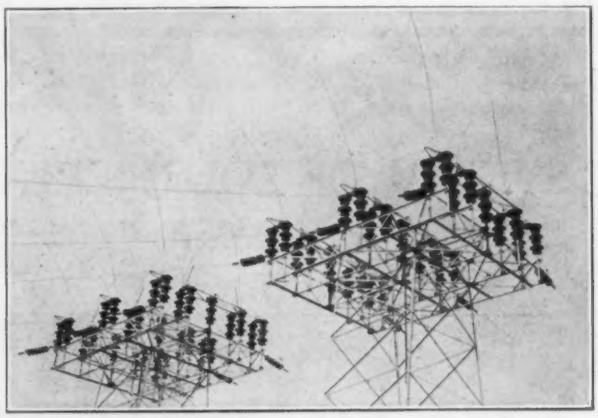
main transmission to San Bernardino. At present two circuits come into this station, the one from the west commencing at power plant No. 3 and following Bishop Creek in a general way. The other circuit enters from the east and is brought from power house No. 6. The transmission line now takes a southerly course following, as a rule, the west side of the Owens valley, passing near Big Pine, Independence and Lone



Three Views of the Substation at Lone Pine.

Pine, there being at the latter place the first transformer station. The line passes to the west of Owens lake and the Hawiee reservoir of the Los Angeles aqueduct, paralleling the aqueduct and the Southern Pacific Railroad through Rose Springs Valley, passing Little Lake, Brown and Inyokern at which point the second transformer station is installed. The general southerly direction is maintained the line passing over a range of hills, thence across Salt Springs Valley to Randsburg, a mining town of importance where the third transformer substation is placed. Crossing another range the line is carried over the Mojave desert in the middle of which the fourth substation is at Victorville. From the desert the line now ascends to a pass in the San Bernardino mountains, following Devils canyon down the south slope and finally terminating at the San Bernardino auxiliary steam station, the total length being 238.16 miles from the control station.

The distribution covering the San Bernardino Valley and the country south of Riverside is all at 33,000 volts, and these circuits of which there are three, are controlled and regulated from this point. One of these circuits covers the northern part of the valley to the westward, the principal point of supply being Rialto. The other circuits are carried together on a line of steel poles, going south, cross the valley into



The 140,000-Volt, Bowie Air-Break, Circuit-Breakers at the Control Station.

Riverside county and incidentally pass through highly cultivated areas and districts characterized by large industrial concerns. Just before entering Riverside, one of the circuits branches to the West, this is known as the West Riverside line. This line passes much highly cultivated land and much which is subservient to a similar cultivation and large population. The line passes through west Riverside, and following the Santa Ana River finally ends at a substation for the supply of the city of Corona. There is a branch from this line to Wineville. The third line supplies the city of Riverside, a contract having been entered into with the municipality to supply all of the current for distribution in the Arlington District of the municipal system. It then passes to the southward a distance of 18 miles through Alessandro and Valverde to Perris which is the center of a very rich agricultural community, entirely dependent however on underground water, raised by pumping, for irrigation. Near Valverde a branch goes southeast a distance of 27 miles to San Jacinto and finally reaches Hemet, 3 miles further, both of these places, like Perris being centers of rich agricultural areas. From Perris the line takes a southwesterly direction, for 16 miles, finally ending at Elsinore, a sizable town prettily situated by a picturesque lake of the same name. These lines are the backbone of a network which is constantly extending. Other main lines are projected, and before this comparatively new enterprise has gotten little better than a good start, there should be possible the reclamation and cultivation of a large part of the many thousands of acres of arid and semi-arid land in this territory through the agency of electric motors driven by power generated from the falling waters of Bishop creek, in some cases nearly three hundred miles away.

Substations.

One of the characteristic features of this system, already mentioned, is the type of substation, or more

correctly termed, transformer station, which type is unique and entirely unlike the practice followed by other power transmission systems. The tendency to the use of so-called outdoor substations has made itself manifest in various parts of the United States within the past year or so but in most cases has been limited to the use of "outdoor" type transformers, the switching apparatus being more or less elaborately housed. The engineers of the Southern Sierras Power Company have carried the open air idea to its logical extreme, and, with the exception of secondary transformer stations, where a local distribution is controlled through a switchboard in which case a house only of sufficient size is used, no housing or protection of any sort from wind or weather has been provided. Poletop air-break switches of the Bowie type have been adopted as standard for all high and intermediate voltage circuits.

The transformer stations are divided into two groups, the style of each group having been consistently standardized. The first group consists of six stations on the high tension, 140,000 volt transmission, while in the second there are eight stations which receive their correct current supply from the intermediate 33,000 volt circuits.

Of the high tension transformer stations the following table will give the location, capacity and distance between stations:

Station.	Capacity.	Distance apart.	Distance from control station.
Control	36,000 kw.	0.	0.
Lone Pine	1,500 kw.	58.	58.
Inyo-Kern	1,500 kw.	67.	125.
Randsburg	1,500 kw.	21.	146.
Victorville	1,500 kw.	61.	207.
San Bernardino,	12,000 kw.	31.	238.

To this list might be added the raising transformer stations at power houses Nos. 3 and 6. Each of these stations being connected with the control station by a single circuit transmission.

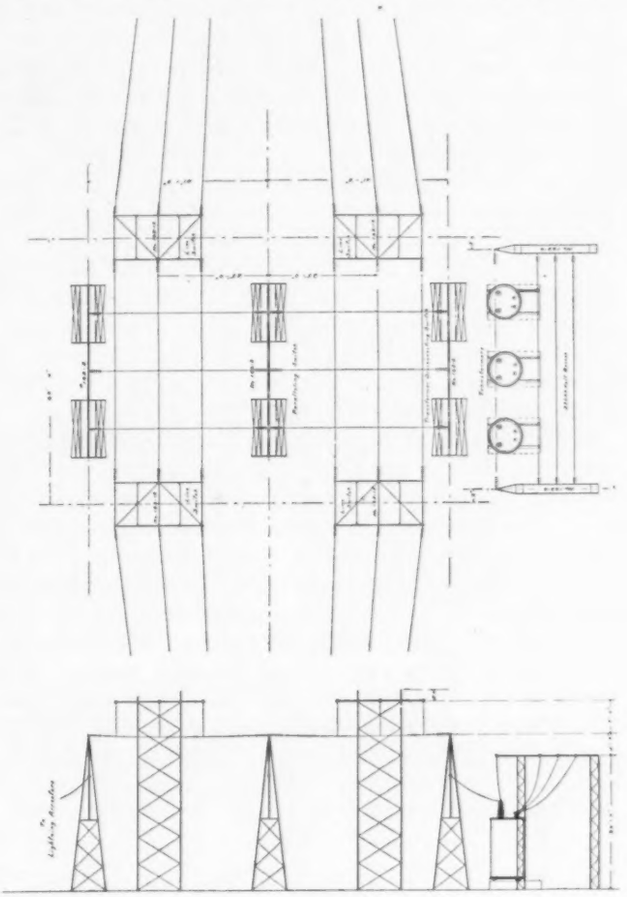
Powerhouse No. 3.	6,750 kw.	4.	4.
Powerhouse No. 6.	2,250 kw.	1.5	1.5

From this it will be seen that the greatest length of transmission, from power house No. 3 to San Bernardino is 242 miles.

Control Station.

The control station is somewhat different from the line stations and is provided for lines feeding in as well as out. The floor of the station is nothing more than a space leveled and rolled on which is erected the tower structures. The plot allotted is sufficient size to accommodate, beside the switching structures, the operator's house, his cottage, a storehouse, etc. The main structure of galvanized steel angles, similar in general dimensions to those used in standard towers, consists of two sets of "A" frame structures spaced about 60 ft. apart, each somewhat outside of the lines from the switch towers. The ends of these structures are connected by two other "A" structures, the whole forming a hollow square. On the first named "A" structures are mounted vertical disconnecting switches and to these, coming from opposite directions are the high tension circuits from power houses 3 and 6. The disconnectors are connected together by a 3-wire bus line stretched across the hollow square. Across the top of the hollow square, above the bus just described, and at right angles thereto, are two bus circuits which continue, each to a main line switch. The upper and lower buses are connected. Below the disconnectors are wooden platforms 10 ft. above the ground on which the operator stands when handling the disconnectors.

Each set of high tension switches consists of two breaks in series, and is mounted on a steel tower structure especially designed for rigidity and the dead-end strain of the transmission line. These switches have a knife break 3 ft. long, the blade of which is pivoted at one end, lifting the free end as it opens. At both ends of the blade are arcing horns made from galvanized iron pipe, the size being 1 in. at the bottom and tapering toward the top. These horns are curved back and away from each other for the purpose of



Plan and Cross-Section of Substation on 140,000-Volt Transmission.

preventing the arc, which is formed in opening, from jumping across the circuit. The free end of the blade, immediately after opening the circuit passes the base of the horn, transferring the arc to the horn. As the blade continues its upward movement, the b'ade transfers the other end of the arc to the other horn and the arc then travels upward between the horns and finally breaks, the entire action taking practically no more time than the opening of the blade.

While the operation of air-break switches on extra high tension circuits has been the cause of more or less skepticism from builders and operators of oil submerged switches, the engineers of this system report so far the utmost satisfaction and surety in operation and, within the means of observation, any un-

usual line disturbances likely to be the cause of damage to apparatus or to service has not manifested itself.

These switches are operated from the switchboard in the operator's house by compressed air, through pipe connection, although a powerful operating mechanism is mounted at the base of the tower. A small induction motor compressor with a steel storage tank of sufficient capacity to operate the switches a number of times in case current should fail, supplies the compressed air. No automatic control is used. Synchronizing between the hydroelectric plants and the steam auxiliary can be done here on the high tension lines and through the means of these switches.

There are to be placed at this station, three 4000 kw. raising or lowering transformers. These will be wound for star connection to the 140,000 volt circuit on one side and for delta connection for 55,000 volts on the other side. They are for the purpose of tieing together the Southern Sierras and the Nevada-California systems, the latter system being operated at the lower voltage.

A set of General Electric, type I, electrolytic lightning arresters is placed at one side and connected through disconnectors to both bus lines.

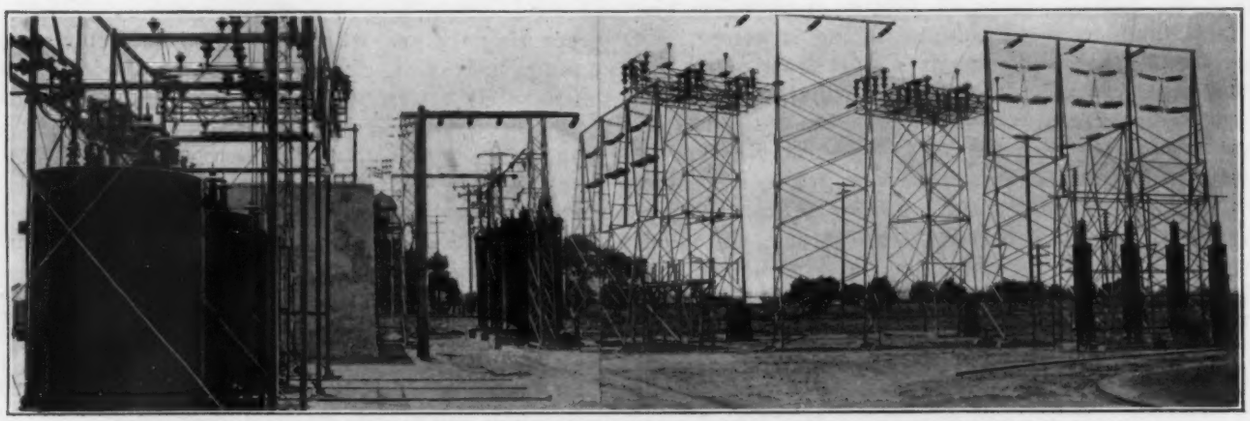
The operator in charge at the control station is virtually load despatcher for the system, the transmission telephone and telegraph being in his charge.

The transformer stations with the exception of the receiving station at San Bernardino, are alike and a description for one will suffice for all.

The station at Lone Pine is about ½ mile east of the town, in the open country which is arid in this locality. There are four sets of high tension double break Bowie switches, mounted as at the control station on steel towers 45 ft. high. These are placed side by side in pairs, the pairs being 60 ft. apart longitudinally and separated between the circuits about 50 ft. Between the pairs of switches are strung the two bus circuits and under these with their axes parallel with the busses are three sets of "A" frame structures. These structures carry each, a set of vertical disconnecting switches of the standard type especially designed for this system. Those on the center structure connect the busses together, those on the structure to the east, connect a circuit to feed a bank of lowering transformers, while those on the more westerly structure have connection to the electrolytic lightning arresters which are placed on concrete bases. Around the arresters is erected a strong wire netting to prevent interference from stray animals or birds. The grounding horn gaps for discharging the arresters are mounted on a pipe structure and their operation is from a wooden platform about 8 ft. high and 30 ft. long. There are three 500 kw. Allis-Chalmers oil-insulated and air cooled transformers provided with water cooling coils to care for overloads. The primary winding is 87,000 volts with a tap for 55,000 volts, the highest voltage to be star connected for use on the 140,000 volt circuits. These transformers are of very heavy construction, the porcelain high tension terminals being, each, about the size of two sugar barrels placed end to end, and being, of course, weatherproof. The cases are cast iron and are mounted on low transfer cars which in turn stand on a track imbedded in a concrete pier 18 in. high. Along the front of the transformers is a transfer track of 8 ft. gauge, and a car on this track may be run to any transformer and the transformer may be moved from the pier to the car and thence to the pit in case of damage or repair. At the end of the track is a concrete lined pit 8 ft. square and 16 ft. deep and over this is a steel gallows frame made of two 6 in. "H" beams and a pair of 15 in. "I" beams across the top. A wire rope double block tackle is operated by a windlass mounted at the side of the frame. By this means a damaged transformer may be lowered into the pit and the core removed and placed on the car or on the ground. There are also a pair of 50 kw. air-oil cooled Westinghouse transformers 33,000 to 2200 volts. These supply a three-phase local distribution to Lone Pine. From this station a 33,000 volt line is carried a distance of 14 miles to Keeler on the east shore of Owens lake. Power from this line is used in operating various chemical recovery works adjacent to the lake. A local superintendent has charge of this station and the district which it covers. The station itself requires but occasional attendance.

From the Inyokern station, there are two 33,000 volt circuits radiating in opposite directions and supply power over a large area, formerly desert, for pumping water.

The Randsburg station is at the end of the main street of that place. From it there are several 33,000 volt circuits. These supply Johannesburg and a num-



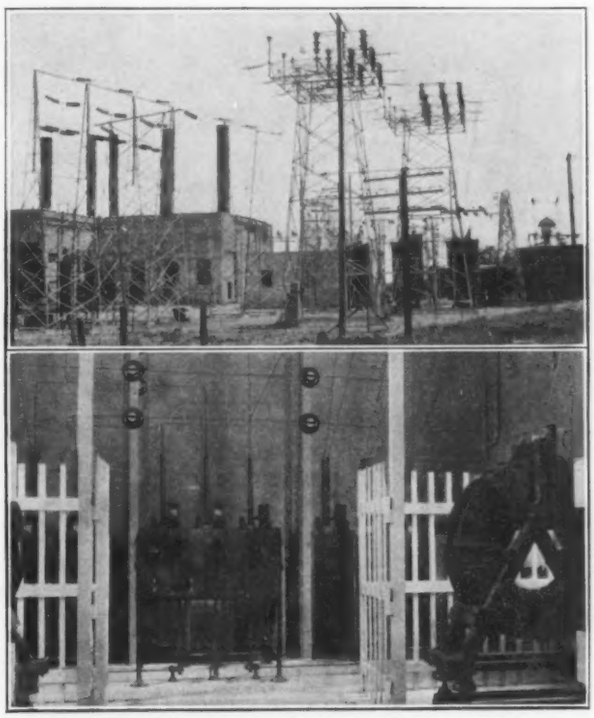
Transformer Station at the San Bernardino Steam Plant. Reactance Coils Are in Concrete Building.

ber of mines and pumping plants in the district. There is also a local lighting circuit. The company has here an office and show room for the sale of electrical fixtures and supplies and with the aid of an efficient sales force has made the settlement quite hospitable and up to date.

The substation at Victorville has not yet been completed but will eventually do its share in turning the Mojave desert into gardens and alfalfa.

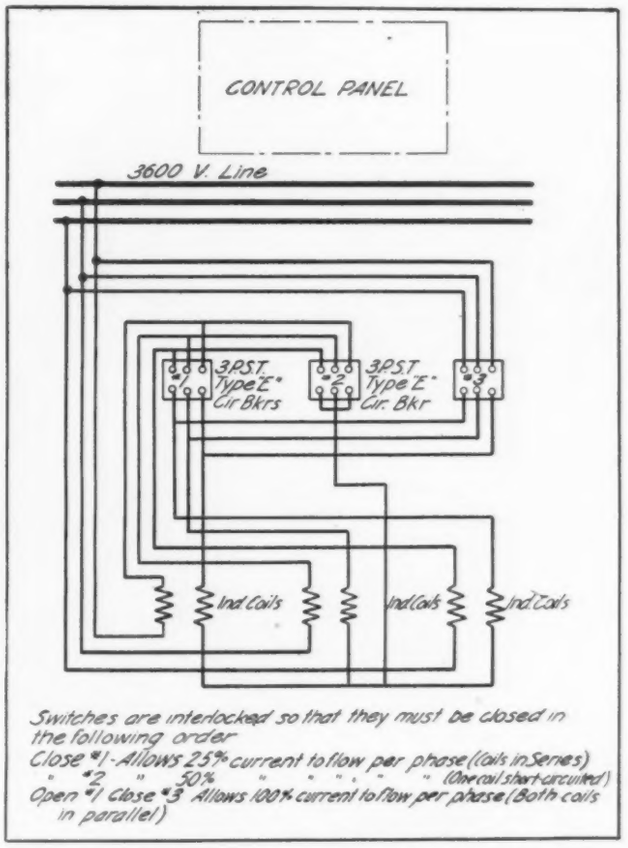
The San Bernardino Terminal Station.

The transmission line terminates at two Bowie, double break switch sets, mounted on towers and similar to those at the control station. The general plan of this station is also similar in its switching arrangements but with a number of added features. The main switches are motor operated and controlled from the switchboard in the power plant. There are three sets of "A" frame structures two of which are on either side of a hollow square. The third is opposite to one of the main switch sets and is connected to it by a bus line and in this structure are the disconnecting switches from which the circuit is carried to a set of General Electric, type I, electrolytic lightning arresters. The bus from the other main switch is supported by a two-pole structural steel frame set in line with the "A" frame just mentioned. Between the end "A" frame structures is strung a cross bus from which are connections to both upper busses and these "A" frames carry disconnecting switches for connections to Allis-Chalmers lowering transformers. But one set of these transformers is in place. There are three transformers in this set of 4000 k.v.a. capacity each. They are wound for 87,000 volts primary to be star connected to the 140,000 volt circuits. The secondaries are wound for 36,000 and 6600 volts, the latter tap permitting the turbo-generators to feed direct to these transformers. These transformers are, due to their high voltage windings and their large capacity, very heavy and bulky and are provided with three sets of copper water cooling coils each. The cases are sheet steel and are mounted on low trucks which rest on concrete piers 5 x 10 ft. A subgrade transfer track passes in front of the transformers and extends to the door opening in the rear of the power house, where a transformer may be taken for repair. A 33,000 volt bus line above the transformers and over the transfer track is carried on two end "A" frame structures which straddle the track. From this bus are feeders which connect to the three valley circuits and to the inductance coils. Two of the valley lines are equipped with Kelman 33,000 volt outdoor type oil circuit breakers mounted on steel towers. The third valley line has a Bowie air-break switch and a similar switch is interposed in a circuit which feeds a secondary set of transformers. This set comprises three Allis-Chalmers water cooled transformers of 2000 k.v.a each, mounted on wheels so as to be movable to the transfer track already described. These are wound for 36,000 to 6600 volts and are intended to connect the steam plant power circuits with the valley lines and incidentally with the transmission through the larger transformers. An angle steel framework over these transformers carries on one side the 36,000 disconnecting switches and on the other those for the 6600 volt circuit.



San Bernardino Steam Plant. Bowie 140,000-Volt Circuit-Breakers in Foreground. 4000 k.v.a. Transformers and Fuel Oil Tank in Background. Reactance House in Center.

Interior of Reactance House, Showing One of the Six Induction Coils on the Right and the Oil-Switch Control in the Background.

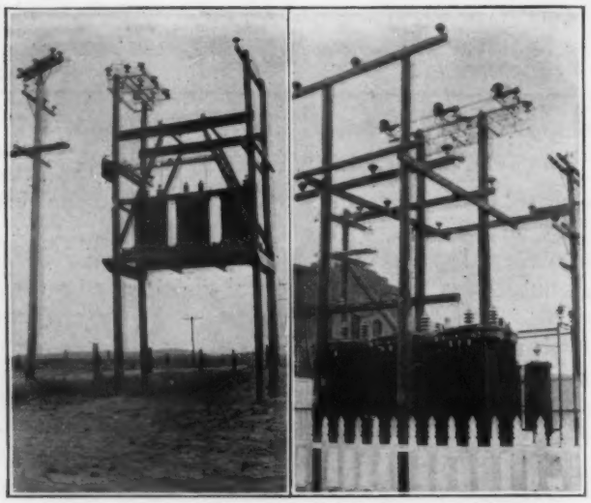

CONTROL PANEL
3600 V. Line
3 P.S.T. Type E Cir Bkrs
#1
#2
3 P.S.T. Type E Cir. Bkr
#3
Ind Coils
Ind Coils
Ind Coils
Switches are interlocked so that they must be closed in the following order
Close #1 - Allows 25% current to flow per phase (Coils in Series)
" #2 " 50% " " " " " (One coil short-circuited)
Open #1 close #3 Allows 100% current to flow per phase (Both coils in parallel)

Switch and Wiring Connections to Inductance Coils.

The reactance coils, sometimes called inductance coils are placed in a one-story reinforced concrete building 42 x 22 ft. There are two sets of these coils consisting of three coils to each set and each set is placed parallel with one side of the building. The purpose of these coils is purely one of line regulation. In using high voltages on long transmission lines, the capacity of the circuits acting as condensers would serve, if the line were open at the receiving end, under certain conditions, to give a higher voltage than at the initial end and in any case a higher voltage than the operating voltage which the machines at the receiving end may be designed for. Under this condition, for instance, it might not be possible to boost the fields of the generators in the steam plant to give a high enough voltage to allow synchronizing within safe limits and without putting a dangerous strain on the generators, transformers, etc. By placing reactance in the form of an open core inductance coil across each phase of the circuit, the capacity effect of the transmission line becomes neutralized and the voltage is brought to a point within the limits of ordinary operation. In operating these reactance coils, they are arranged so that the two sets may be placed in series with each other, or by a change in connections, may be placed singly, cutting one set out, or may be placed in parallel, depending on the amount of reactance necessary for the condition at hand. These various changes are made automatically by three sets of three-pole 36,000 volt oil switches. The coils themselves consist of twelve flat coils of one turn per layer and having 60 turns of ribbon wire, all very heavily insulated. The coils are mounted in hard wood frames heavily varnished.

Distribution Line Substations.

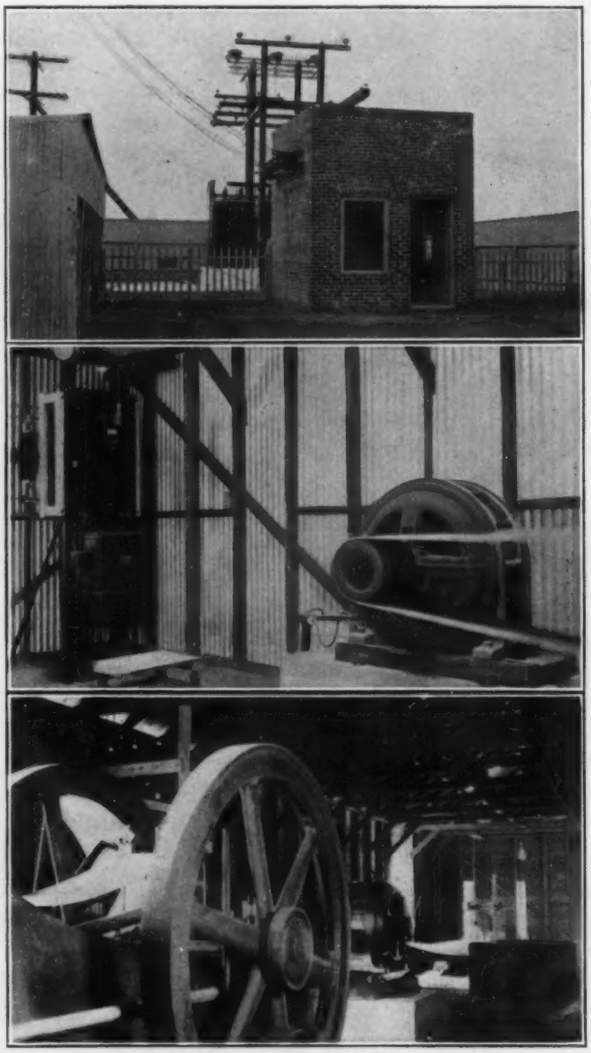
The substations on the 33,000 volt distribution lines are much alike. Where a local distribution for lighting is had, there is provided a switchboard which is enclosed. All secondary lines are delta connected to the transformers and have a potential of 2200 volts. This potential is supplied to all motors of 15 h.p. and over. Where smaller motors are installed, local transformers are supplied to give the proper voltage reduction.



Typical Transformer Installation on 36,000-Volt Distribution in Irrigation District, Left View. Transformers and Arresters at Perris, Right.

A list of the substations, with the distances between and their transformer capacity follows:

Substation.	Capacity.	Distance.	Total Length.
San Bernardino S. Plant.....	200 k.v.a.	0. miles	0. miles
Rialto Line:			
Lytle Creek	300 k.v.a.	8. miles	8. miles
Bloomington	300 k.v.a.	inc.	
West Riverside Line:			
West Riverside .....1500 k.v.a.		12. miles	20. miles
Corona	600 k.v.a.	17. miles	37. miles
Wineville (branch)	300 k.v.a.	4. miles	41. miles
Perris Line:			
Perris (from S. B. S. P.)..1600 k.v.a.		27. miles	68. miles
San Jacinto (branch)	450 k.v.a.	17. miles	85. miles
Hemet	450 k.v.a.	3. miles	88. miles
Elsinore	400 k.v.a.	17. miles	105. miles
Nine Isolated Sets .....25-300 k.v.a.			



Substation and Yard at Perris.
Typical Pumping-Motor Installation.
Gas Engine Displaced by Motor-Driving Deep Well Pump.

The stringing of a second circuit on lines built for two circuits will bring the total length of 33,000 volt circuit to 140 miles. The total transformer capacity installed is 6400 k.v.a. and the total number of stations is 19.

The station at Perris, which is typical of most of the others is enclosed by a high wooden fence. In the center of the enclosure are three 300 k.v.a. Ft. Wayne, air-oil cooled outdoor type transformers wound 33,000

to 2200 volts. These are mounted on concrete bases 5 x 15 ft. x 2 ft. high. An equipment of 4 Westinghouse electrolytic lightning arresters is mounted on a concrete base of the same size as that provided for the transformers. Connection to the transmission line is made through one set of Bowie, type K, air-break switches. A 4-panel black slate Westinghouse switchboard with voltmeters, ammeters, polyphase integrating, and type U graphic recording voltmeter is housed in a brick building, 14 x 12 ft. inside, and 12 ft. high. This building has a concrete roof and floor, two windows and a door, and from it are carried three 2200 volt circuits. In the district about Perris the pumping load amounts to about 2000 h. p. Adjoining the transformer station is the company office and store and a material yard and storehouse.

Isolated transformer stations supplying current for a group of pumping plants are constructed upon wooden poles, the transformers being mounted on elevated platforms and the connection to the transmission being made through Bowie switches, mounted on the top of the structure.

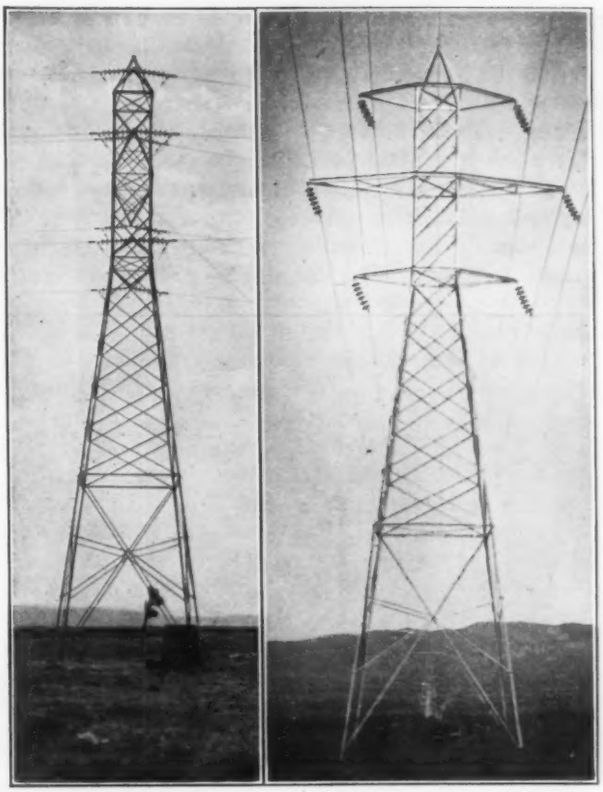
Pumping Plants.

Views in two typical pumping plants near Perris are shown. Three plants are generally housed in a corrugated iron building, the one shown being 20 x 60 ft. The length is due to the necessity of belting to the pump. The motor and equipments are held as near to a standard as possible. In this case, a General Electric 30 h.p., 2200 volt, 850 r.p.m. motor is used, and is belted to a Pomona double acting deep well pump. The switchboard in one panel carries a Westinghouse polyphase wattmeter. The motor wiring is brought from the pole to the switchboard and motor in steel duct. The strongest competitor in this district is the gasoline engine run on "tops," a low grade of distillate. Notwithstanding that this is so cheap as to make its cost little more than the freight, the motor by its safety, cleanliness and practically no cost of upkeep is rapidly displacing the engines. An illustration of this is shown where the motor has been installed ahead of a gas engine of equal power, which is now idle.

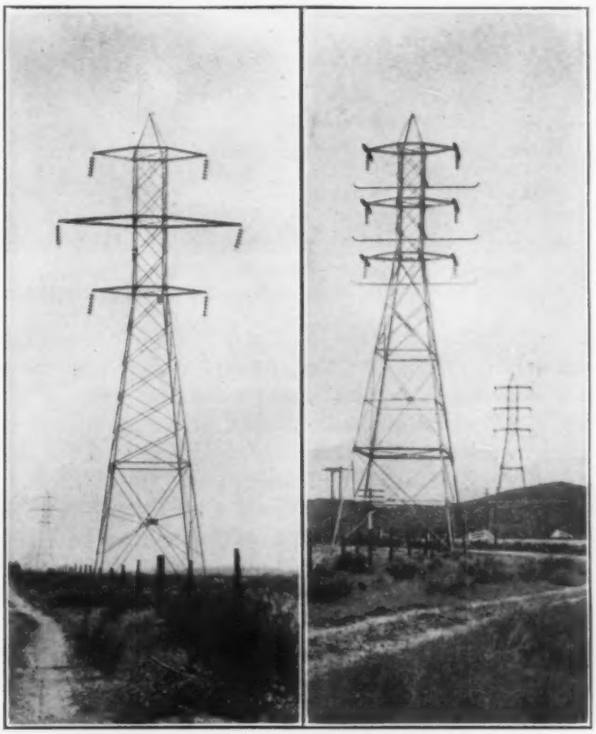
Transmission Line Specifications.

In the design of the transmission lines, while types of towers in general use have become more or less standard, it was considered that some conditions to be found on this system would necessitate refinements in many parts and much thought and time has been expended by the engineers to produce the desired results.

The towers for the main transmission line were supplied by Milliken Bros. of New York and conform in general with a type supplied for many systems by this company. Except where special requirement necessitates greater strength or additional height a standard structure of light weight is used. This follows the usual design of four corner angles 3 x ¼ and 2¾ x ¼ in., which at the ground line are 15½ ft. apart, incline toward the center until at the lowest crossarm they are 4½ ft. apart. From this point to the upper crossarm, the corners are parallel, the distance being 20 ft., beyond which the angles meet in the center and form the support of the ground wire. The upper and lower crossarms are formed of two 4 in., 5¼ lb. channels, which come together at their extremities. These arms are 16½ ft. long. The middle crossarm is longer than the others, formed of 5 in., 6½ lb. channels, and measures 26½ ft. The height from the



A Dead-End Tower (Left). Effect of Heavy Wind on Transmission Line (Right).

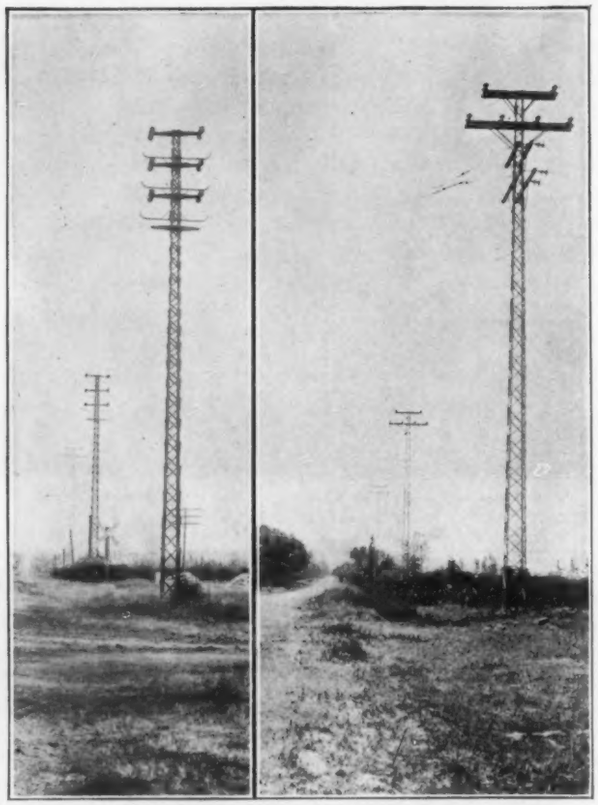


Standard Transmission Tower (Left). Special Towers at Santa Fe Railway Crossing (Right).

ground to the lower crossarm is 44 ft., and to the top of the structure 70 ft.

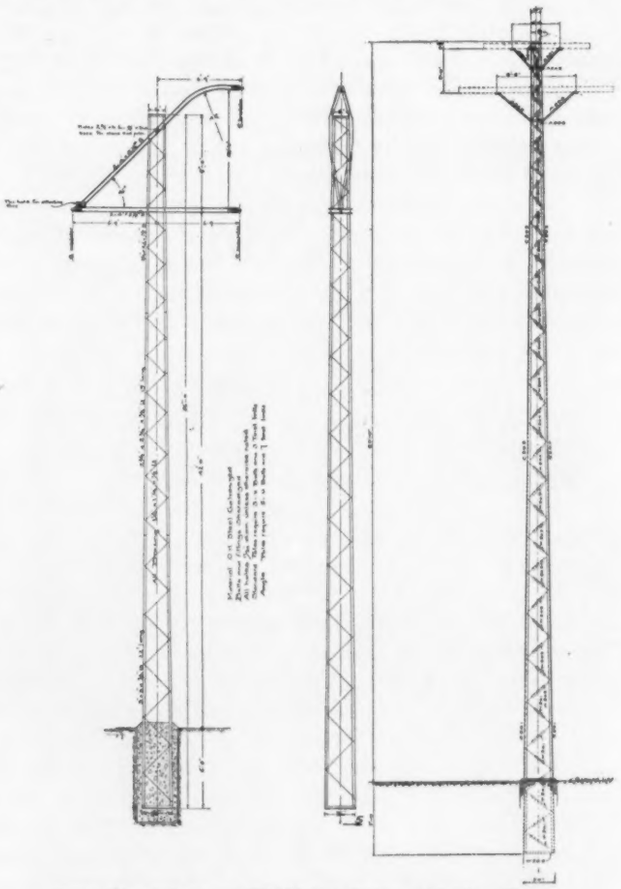
To the bottom of the corner angles are bolted the legs which are also 3x ¼ in. angles. These are 6½ ft. long. On the bottom of each leg is a ground plate. This plate is a piece of 12 in. channel 2 ft. long.

In fastening the channel plate to the leg, a right-angled hole is cut in the web of the channel which the angle exactly fits. Two flat pins set edgewise to the channel web are passed through both sides of the angle



Special Steel Poles at Railway Crossing (Left). Standard Steel Poles of 36,000-Volt Distribution (Right).

through holes properly punched. One of these pins is below and one above the channel web. The towers, except in some special cases, were first erected without concrete around the bases, it being found that much of the ground encountered was sufficiently compact to hold the tower under any probable strain. In some stretches, particularly west of Owens lake and for a good many miles to the southward, violent winds occur at certain times of the year and there is even danger of washouts from cloudbursts in the mountains nearby. For this reason long stretches of the line have been concreted around the tower legs. This is an extensive undertaking, expensive and annoying and one that no company desires to make unless positively necessary. This is especially the case here where the cost of cement is high and all water used must be hauled. The accompanying view shows a gang at work placing concrete. The water wagon with a pump mounted behind is in the background. In doing the work a preliminary gang goes ahead, guying the tower from both sides, then digging the earth from around the legs until the full depth is reached and the channel plate is hanging free. These holes are about 3 ft. in diameter. The weight of the tower is carried by timbers placed under four 3 x ¼ in. steel angles which are bolted around the base of the tower at the ground line. These angles being used only on concreted towers as stiffeners. Another gang distributes materials at each tower, cement, sand, and sections of 12 in. stovepipe. The concrete is first laid in the bottom of the holes to a thickness of 6 in.



Two Elevations of Wishbone Poles at Left. Elevation of Steel Pole for 36,000-Volt Circuits on Right.

under the channel and then 18 in. over it. The sheet iron stovepipe sections are then placed around the leg up to the ground line and these are filled with concrete. The hole is then refilled with earth. As soon as the concrete has become hard the guys are removed from the tower.

Where possible about 30 per cent of broken rock was used in the concrete mixture, but the plan was to adhere as nearly as possible to a 1 to 6 mixture. The cement requirement was about 1 bbl. per leg at a cost of $4.50 to $5 per bbl., and the total cost including overhead charges averaged $70 per tower or $560 per mile.

Dead-end towers are of frequent occurrence. A table is given under the subject of line specifications which shows the method of determining dead-ends. These towers are also used at transpositions and railroad crossings.

There are four types of special towers, all of greater weight than the standard towers; one of these

is for special dead-end strains, one for Southern Pacific crossing requirements and one for Santa Fe crossing requirements. The accompanying table gives the weights of all of the towers. The Southern Pacific requirement is conservative and probably heavier than necessary for any probable strain. The Santa Fe requirements is evidently based on bridge specifications without attempting a study of the probable strains. The weight and cost are excessive.

Classification.	No.	Unit Weight. Pounds.	Total Weight. Pounds.
Standard	1788	3,640	6,511,960
Angle	22	4,560	100,320
10-ft. Extensions	34	4,640	157,760
Transportation	8	4,000	32,000
S. P. Co. Crossing	10	6,700	67,000
Santa Fe Railway Crossing	11	11,400	125,400
Totals	1874		6,994,440

Tower Tests.

Tests on the various towers were made before the line was put in service, part of these tests being made in the East at the point of manufacture and part locally. In the determination of the hold which the channel plate on the bottom of the legs resisted the attempt to pull out of the ground vertically, a tackle was rigged to exert a vertical pull with the leg and channel buried in molders sand, considered an extreme condition for weakness of hold. These tests showed failure on an average pull of 35,000 lb., and the material broke out in a cone 30 degrees from the vertical.

The normal strain at the end of the crossarm, under the worst conditions is about 300 lb. Where three wires are broken, the maximum strain which would occur on the end of the long arm does not exceed 4500 lb. Horizontal tests with a pull at the end of the long arm, failed by the twisting of the corner members of the tower with a pull on the arm of 16,000 lb.

The following representative test made by Mr. C. O. Poole on standard towers at the manufacturers' plant gave the following results:

Test No. 6. Ereast Pull on Tower Applied at Elevation of Middle Crossarm.

Load. Pounds.	Deflection. Inches.	Set.
2,000	0.25	
4,000	0.60	
6,000	0.75	
8,000	1.10	
8,500	1.20	
9,500	1.30	
11,000	1.40	
12,000	1.60	0.25 in.
13,000	2.12	
14,000	2.25	
15,000	2.50	
16,500	3.50	Failed

Towers are regularly spaced 660 ft. apart, or 8 to the mile.

Wishbone Poles.

The wishbone type pole follows a design by Manifold & Poole, engineers, and like the towers, were built by Milliken Bros. This pole is a compromise between the tower and the ordinary pole, to be used where spacing is necessarily somewhat closer than with the towers, where one circuit only is to be carried and strength and rigidity and permanence of a steel structure is desired. The pole consists of four angles in sizes 3 x ¼, 2¾ x 3/16 and 2¼ x ⅛ in., spaced at the butt 30 in. apart and at the top 16 in. The corner angles are held in position and braced by steel angle latticework. These angles are placed diagonally in both directions, averaging every 24 in. and on all four sides using 1¼ x ⅛ in. angles. The length of the pole is 56 ft. There are two crossarms, each formed of a pair of steel 4 in., 5¼ lb. channels. The lower arm is horizontal, 13½ ft. long. The upper arm is curved for a part of its length. One end is bolted to the shorter end of the horizontal arm, the center is bolted to the top of the pole, while the curved half of the arm extends to one side. This odd connection of crossarms has somewhat the appearance of a wishbone, hence the name. By the arrangement a triangle is formed by the ends of the arms. These poles are placed in the ground to a depth of 6 ft. and the holes are filled with concrete.

Wishbone poles are used for the feeder circuits from No. 3 and No. 6 powerhouses to the control station, there being altogether 5½ miles of this line in place. These poles are spaced 12 to the mile. The weight is 1700 lb. each.

The insulator equipment of all the 140,000 volt circuit consist of 6-part suspension insulators. With the exception of ten miles the tower line is equipped with Locke No. 2036 insulators. The remaining ten miles and the Wishbone lines are equipped with Ohio Brass Company, No. 10567 insulators.

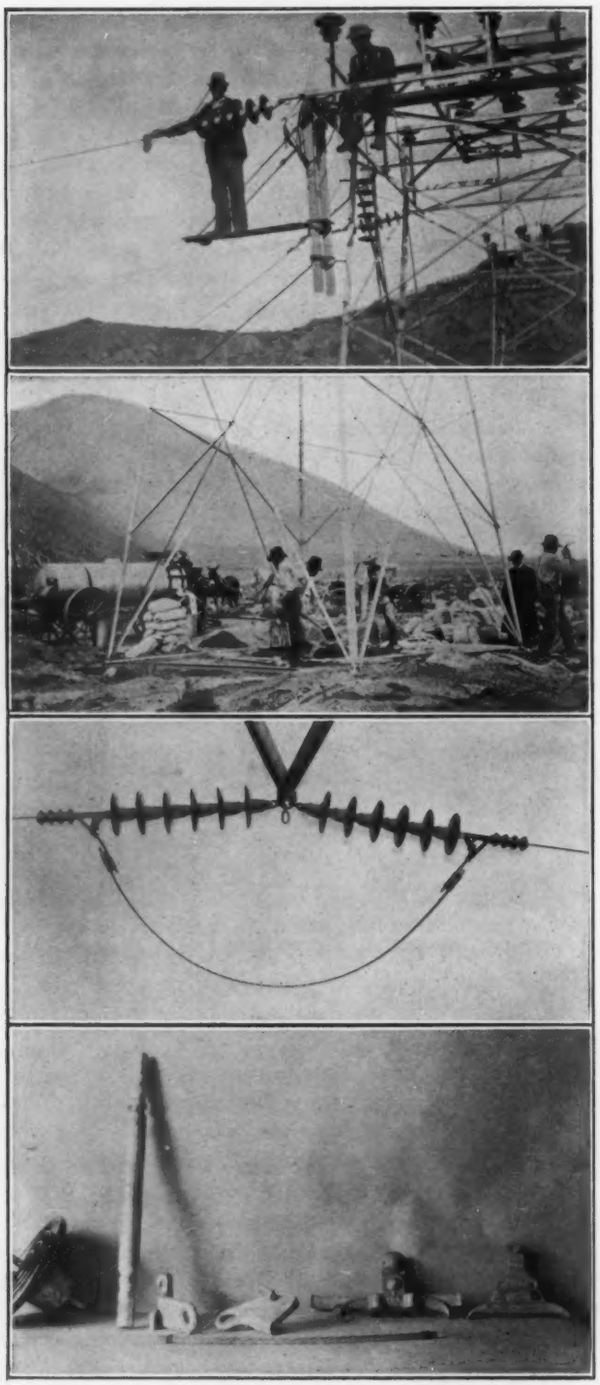
Where the lines are carried over railroad crossings, the poles or towers on either side of the crossing are equipped with three curved guards made of steel channels. These are supported from the structure by channel brackets. In the instance of the towers, these channels stand 4 ft. out from the body of the tower. They serve to ground a broken wire in falling which will first strike this guard. On towers equipped with guards and also towers next to a line switch, the middle arm is made the same length as the others.

Of the 33,000 volt distributing lines from San Bernardino, there are about 14 miles of steel poles. These have a length of 60 ft. and are formed, like the wishbone poles, of four angles and lattice angles.

The corner angles are 2½ x 3/16 in., 2½ x ⅛ in., and 2 x ⅛ in., the lattice angles being 1½ x ⅛ in. These poles carry two wooden crossarms, the upper one carrying two pins and the lower four, for the support of two circuits. At railroad crossings and on corners a considerably heavier construction is used although the pole is of the same outline design. These poles are spaced 12 to the mile. For all other circuits, 35 and 40 ft. cedar poles are used with standard single and two arm construction. All structural steel throughout is galvanized and all bolts are shear-ardized.

A wooden pole telephone line has been built from the control station to San Bernardino. This was built expressly for the purpose of keeping the signal line

entirely free from the transmission, and, to obviate possible inductive effects the line, while parallel to, averages at least one mile distant from the transmission. This line consists of 30 ft. round cedar poles, spaced 25 to the mile. Each pole carries one two-pin crossarm and carries two No. 8 hard drawn copper



Method of Fastening Conductors at Dead-End.
Placing Concrete Footings About Tower Legs.
Near View of Dead-End Connection on Tower.
Insulator Section, Wire Connector, Wire Clamps and Guy Clamps.

wires. It is operated with both telephone and telegraph equipment simultaneously and part of the line is used by arrangement with the Interstate Telephone Company for commercial messages.

The circuits on the wishbone poles and also on the 33,000 volt distribution are copper wire, the former being No. 0, 7-strand, while the latter is in various sizes depending upon the service.

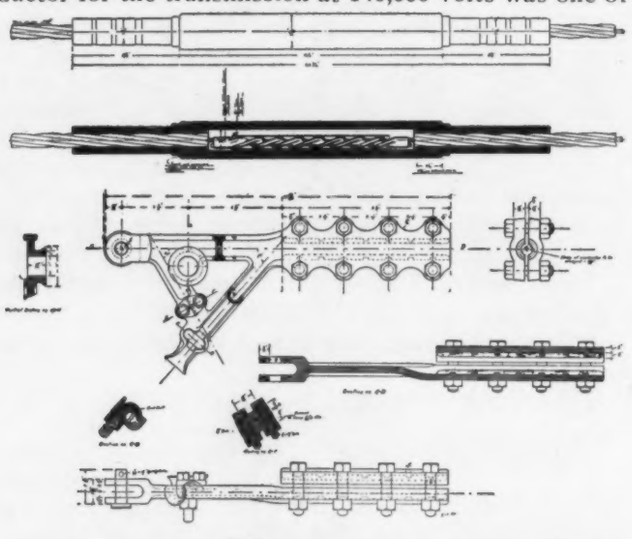
Special Line Fittings.

There are a number of special fittings for wire connections to towers and insulators. These consist of cast steel clamps in various forms to be used where a guy wire is fastened to a tower, the clamp being so shaped as to conform with a joint between angle members and containing an eye for fastening the wire. In fastening the aluminum steel conductor it was necessary to provide a means of fastening the steel core and the aluminum strand independently. Dead-end clamps consist of a malleable iron clamp with eight bolts and an aluminum lining. There is an offset terminated by a single "J" bolt clamp, through which the aluminum wires are brought and from which connection is made to the jumper. The steel core wire is carried straight back and fastened through a hole provided in the casting. The end of the casting is provided with an eye for a ⅝ in. bolt to fasten to the insulator.

The line connectors consist of a cast aluminum cylinder having an inside diameter somewhat larger than the conductor. The ends of the cylinder are smaller and just pass over the cable, and one of these ends is screwed into the main body of the cylinder while the other is cast solid. The ends of the conductor are untwisted, a standard joint is made between the steel wires, the cylinder is then slipped over the conductor until the steel wire joint is inside and the loose end is slipped down from the opposite direction and screwed into the cylinder, the aluminum wires extending into the cylinder from both ends, but not held tightly. A specially constructed hydraulic vice is brought to bear on each of the ends and these are squeezed down tightly around the aluminum conductors making a joint which developes the entire strength of the wire.

Aluminum-Steel Conductors.

The problem of a proper and satisfactory conductor for the transmission at 140,000 volts was one of



Details of Aluminum Wire Connector and Dead-End Clamp.

no mean study and this has been very carefully considered. The use of so-called aluminum-steel conductor fulfilled the requirement due to electrical phenomena encountered in the use of extreme voltages, such as corona loss, also the mechanical properties necessary. Due to its newness little was known from experiences on other systems. The electrical and mechanical features were carefully worked out and a system of standards adopted in placing this wire and the results seem to be satisfactory and in accordance with the calculations of the engineers.

The following electrical and mechanical data given by Messrs. Manifold & Poole, showing the method followed in making calculations and the results obtained.

Actual length of line	238.16 miles
Actual length measured along wire	239 miles
Weight of aluminum-steel conductor in line (6 wires)	2,197,000 pounds
Equipment of lines:	
Insulators	12,948
Dead end clamps	3,072
Parallel groove clamps	3,072
Suspension clamps	9,876
Guys (guys on tangents come off when towers are corrected)	550
Ground wire	147 miles
Concrete	2,302 cu. yds.
Line Constants:	
Cross section 6 aluminum strands	211,160 c. m.
Cross section 1 steel strand	34,970 c. m.
Cross section cable	246,130 c. m.
Weight per ft. of cable	0.29 pound
Diameter of cable (0.5622 in.)	9/16 inch
Average distance between wires	168 inches

L = Inductance = 2.14 millihenries per mile.
C = Capacity = 0.014 microfarads per mile.
X = Reactance = 0.98 ohms per mile.
b = Cap. Susceptance = 0.0000053 ohms. per mile.
r = Resistance = 0.42 ohms per mile.
ϵ = P. F. angle of line = 67°.
z = Impedence = 0.45 ohms per mile.

Kilowatts delivered to Receiver.	Receiver Voltage 50,000. Percent Variation	Generated Voltage	Receiver Voltage 87,000 Percent Variation	Gener'td Voltage	Receiver Voltage 140,000 Percent Variation	Gener'td Voltage.
0	16.3% rise	43000	16.3% rise	74800	16.3% rise	120300
1000	11.0% "	45000	14.2% "	76000	15.8% "	121000
2000	6.1% "	47100	12.1% "	77500	15.0% "	121900
3000	.5% "	49700	10.3% "	78700	14.0% "	122800
4000	4.8% drop	52600	8.8% "	79900	13.2% "	123600
5000	10.6% "	56000	7.3% "	81000	12.7% "	124200
6000	19.6% "	59800	5.8% "	82200	12.2% "	124800
7000			4.2% "	83400	11.6% "	125500
8000			2.8% "	84600	11.0% "	126200
9000			1.0% "	86100	10.4% "	126900
10000			.7% drop	87700	9.5% "	127700
11000			2.5% "	89300	9.0% "	128400
12000			4.4% "	91000	8.3% "	129200
13000			6.3% "	92800	7.7% "	130000
14000			7.9% "	94500	7.1% "	130700
15000			9.7% "	96300	6.5% "	131500
16000			11.4% "	98200	5.8% "	132400
17000			13.0% "	100000	5.0% "	133200
18000			15.4% "	102900	4.3% "	134100
19000			16.0% "	103500	3.8% "	135000
20000			17.7% "	105800	3.0% "	136000
21000					2.4% "	136900
22000					1.6% "	137900
23000					.9% "	138900
24000					----	139900
25000					.6% drop	141000
26000					1.2% "	142000
27000					2.2% "	143000
28000					2.7% "	144000
29000					3.5% "	145000
30000					4.0% "	146000

Table of Calculated Line Regulation at 80% Power Factor.

The aluminum-steel cable is made in a single strand of seven wires, the six helical wires of aluminum and the center or core wire of steel of unusually high tensile strength.

Following is a table of characteristics of this cable:

	Wt. per ft. lb. Each wire.	Total.	Modulus of Elasticity.	Elastic Limit. Lb. per sq. in.	Coefficient Expansion Deg. Fahr.	Ult. Ten. Strength Each wire lb.	Total lb.
Steel	0.0935	0.0935	30,000,000	130,000	0.0000064	3,560	3,560
Aluminum	0.0325	0.1950	9,000,000	14,000	0.0000128	384	2,304
Total ...		0,2885	12,000,000		0.00001052		5,864

Deflection.

In stringing the cable a tension of 1500 lb. at a temperature of 70 deg. F. was adopted. It was found that a stretch of one-tenth of one per cent was necessary before the outer aluminum strands came in contact with the steel core. Beyond this point the metals act together. To give this initial stretch to the steel required a strain of 833 lb.

On the preceding assumption, the following figures were made for a 1000 ft. span:

Using the formulas, $d = \frac{c^2 W}{8t}$

$$L = c + \frac{8d^2}{3c}$$

Where:

L = length of wire in span.

d = deflection in feet.

c = span in feet = 1,000.

W = weight per ft.

T. = temperature.

t = tension in lb.

$t_1 = t - 833$.

s = total stretch, $= s_1 + s_2 + s_3$.

s_1 = stretch due to t_1 acting on whole cable.

s_2 = stretch due to 833 lb. acting upon steel core.

s_3 = stetch due to temperature T.

1. Find the deflection with a tension of 1500 lb. 70° F. = 24.2 ft.

2. Find the length of the wire in the span with the above deflection = 1001.556 ft.

3. Assume that the length of the wire is released from any tension and reduced in temperature to zero, assumed as the lowest that may be expected on the line. The length will be found to be = 999.534 ft.

4. The difference between 2 and 3 gives 2.022 ft., as the stretch due to a strain of 833 lb. acting on the steel core having a modulus of elasticity of 30×10^7 and allowing a stretch of 1 ft. to the wire, plus the stretch due to $1500 - 833 = 667$ lb., acting on the whole cable, with a modulus of elasticity of 12×10^6 and giving a stretch of 0.286 ft., plus the stretch due to temperature, with a coefficient of expansion, of 0.00001052, which gives a stretch of $0.00001052 \times 1000 \times 70 = 0.736$ ft.

5. Select suitable deflections, and, working backward along the above lines, find corresponding temperatures. A table may then be prepared as follows:

Span: 1000 ft. Actual length of cable stressed at 0° F. = 999.534 ft.

L_1	d.	t	t_1	s	s_1	s_2	s_3	T.
1001.556	24.2	1500.	667.	2.022	0.286	1.	0.736	70.0° F.
1001.290	22.0	1650.	817.	1.756	0.350	1.	0.406	38.6° F.
1001.066	20.0	1814.	981.	1.532	0.420	1.	0.112	10.6° F.
1001.805	26.0	1395.	562.	2.271	0.241	1.	1.032	98.0° F.
1002.090	28.0	1295.	462.	2.556	0.198	1.	1.358	129.0° F.

By plotting the above table on cross section paper, the deflection due to any temperature can be determined.

The following table has been compiled from the preceding method:

TABLE OF SAGS
ALUMINUM STEEL CABLE
Sierras Construction Co., June 17 1912

SPAN	TEMPERATURE FAHR.													
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°
500	3.2	3.8	4.0	4.4	4.8	5.2	5.6	6.0	6.5	7.0	7.4	7.9	8.4	8.8	9.3	9.8
550	4.1	4.5	4.9	5.4	4.8	5.3	6.8	7.3	7.8	8.4	8.9	9.4	9.9	10.3	10.8	11.3
600	5.0	5.5	6.0	6.6	7.1	7.6	8.1	8.7	9.2	9.8	10.3	10.9	11.5	12.0	12.5	13.0
650	6.4	7.0	7.6	8.2	8.7	9.3	9.9	10.5	11.1	11.7	12.3	12.9	13.5	14.0	14.6	15.2
700	7.4	8.0	8.6	9.2	9.8	10.4	11.0	11.7	12.3	13.0	13.6	14.3	15.0	15.5	16.1	16.7
750	8.9	9.6	10.3	11.0	11.6	12.2	12.8	13.5	14.2	14.9	15.5	16.2	16.9	17.6	18.1	18.6
800	10.4	11.1	11.8	12.5	13.2	13.9	14.6	15.3	16.0	16.7	17.4	18.1	18.8	19.4	20.0	20.6
850	12.2	12.9	13.7	14.5	15.2	15.9	16.6	17.3	18.0	18.7	19.4	20.1	20.8	21.5	22.2	22.8
900	14.0	14.8	15.6	16.4	17.2	18.0	18.8	19.6	20.2	21.0	21.6	22.3	23.0	23.6	24.3	25.0
950	16.2	17.0	17.8	18.6	19.4	20.2	21.0	21.6	22.3	23.0	23.6	24.3	25.0	25.6	26.3	27.0
1000	18.4	19.2	20.0	20.8	21.6	22.4	23.2	24.0	24.6	25.6	26.2	27.0	27.5	28.1	28.7	29.4
1050	21.0	21.9	22.8	23.6	24.4	25.2	26.0	26.6	27.3	28.0	28.6	29.3	30.0	30.6	31.3	32.0
1100	23.6	24.5	25.4	26.2	27.0	27.8	28.6	29.3	30.0	30.7	31.4	32.1	32.7	33.2	33.7	34.2
1150	26.6	27.4	28.2	29.0	29.8	30.5	31.2	32.0	32.7	33.4	34.0	34.6	35.2	35.8	36.0	37.0
1200	29.5	30.3	31.1	31.9	32.8	33.3	34.0	34.7	35.4	36.0	36.7	37.4	38.0	38.5	39.0	39.5

SOUTHERN SIERRAS POWER CO. MANIFOLD & POOLE, ENGRS.

Dead-Ending.

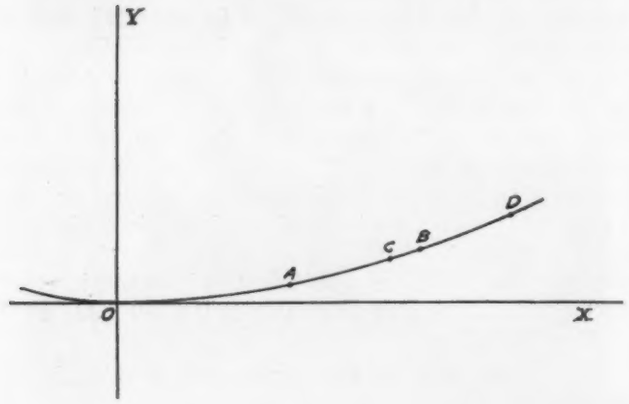
At all horizontal angles over 2 degrees the lines have been dead-ended and jumpers used connecting and continuing the circuit around the insulators. This practice is also followed on long tangents, where dead-ends are introduced about every five miles. In depressions where a shortening of the wire due to low temperatures might cause uplift on the insulators of the low tower, dead-ending has also been resorted to. To determine, before stringing the wire if the lines on a tower in a depression would require dead-ending, the following method was devised; upon determining that the tension on the wire at zero temperature would be 2500 lb.

$$\text{A curve } y = \frac{W x^2}{2 h} \text{ is drawn,}$$

where

W = weight of wire per unit of length.

H = tension in cable at lowest point and constant horizontal tension throughout.



It will be seen that if two adjoining spans overlap, there is no upward resultant, as, for instance, A—B and C—D. If they do not overlap, there is an upward resultant and a dead end is required.

Example: Let the angle of slope A to B = 2°, and from C to D = 8°, the distance from A to B = 600 ft., and from C to D = 800 ft.

$$\frac{dy}{dx} = \frac{Wx}{H} = \frac{0.288\ x}{2500} = \tan 2°$$

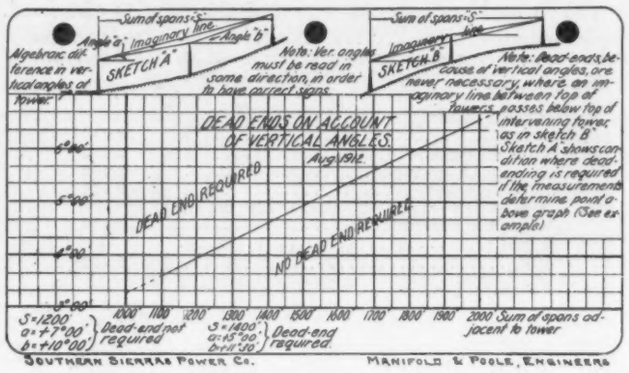
Whence x = 303 ft. = distance from 0 to center of span A—B;

Likewise x = 1203 ft. = distance from 0 to center of span C—D;

Then 1203 — 303 = 900 ft. which equals the distance from center to center of spans along the curve. Hence with the span given, dead-ending would be required.

If however, both spans were 1000 ft., dead-ending would not be required.

From this method the following curve for field use has been compiled.


Sum of spans "S"
Angle "a" Imaginary line Angle "b"
Algebraic difference in vertical angles of towers
SKETCH A
Note: Ver. angles must be read in some direction, in order to have correct signs.
Sum of spans "S"
Imaginary line
SKETCH B
Note: Dead ends, because of vertical angles, are never necessary, where an imaginary line between top of towers passes below top of intervening tower, as in sketch B. Sketch A shows condition where dead-ending is required if the measurements determine, point above graph (See example)
DEAD ENDS ON ACCOUNT OF VERTICAL ANGLES.
Angle "a"
6°00'
5°00'
4°00'
3°00'
DEAD END REQUIRED
NO DEAD END REQUIRED
1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 Sum of spans adjacent to tower
S=1200 a=+7°00' b=+10°00' Dead-end not required
S=1400 a=+5°30' b=+1°30' Dead-end required.
SOUTHERN SIERRAS POWER CO. MANIFOLD & POOLE, ENGINEERS

Field Chart for Determining Dead-Ends.

Both transmission circuits are transposed three complete turns, between the control station and the San Bernardino terminal. Transpositions are accomplished on one tower somewhat heavier than the standard tower and carrying besides three double sets of insulators for dead-ending, on each circuit, three additional sets on the jumpers. There are eight transposition towers.

A ground wire is carried above the circuits and is clamped solid to the top of the tower structure. This is a 3/8 in. Siemens-Martin double galvanized steel strand, of seven wires with an ultimate tensile strength of 6800 lb.

Nevada-California Company Transmission Lines.

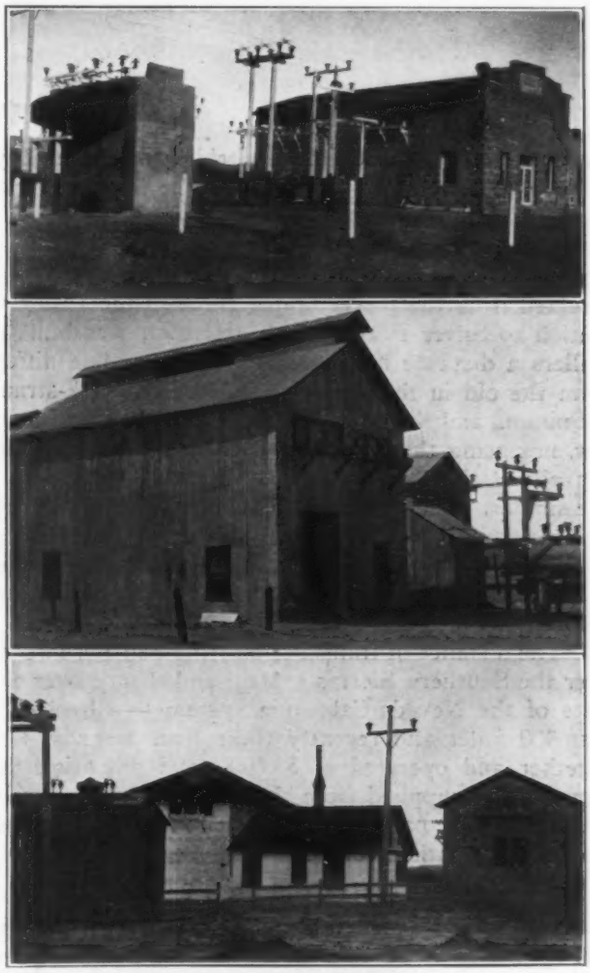
What has been said as to the nature of the territory over which the Southern Sierras transmission lines are carried might apply equally well to a comparatively large area in the western part of the "Sagebrush" state. This part of Nevada is famous for its gold mining activity and particularly the rapid growth of this industry within recent years. It was to supply an insistent and rapidly growing need for power in Goldfield, Tonopah and the districts surrounding those cities in the years of 1904-5, that the nearest available water power was developed on Bishop creek and a transmission line built. Even as recently as the date named the development of the long distance transmission of power was in no wise advanced to the state in which it is found today and many intricate problems were encountered which today would appear as matters of routine. The power plant which was built at this time, now known as No. 4 in a series of five plants now installed on Bishop creek has been already described in the first part of this article. The transmission line which was at that time built consisted of a

Silver Peak Substation in the Nevada Desert.

single 3-wire circuit mounted on wooden poles. This line was unique in that a cross arm carrying two of the wires of the circuit was bolted in the usual manner to the top of the pole, while an extension in the form of an inverted "U" made of a 4 in. steel channel was bolted to the poletop so that on the bend, which is at the highest point, was placed the insulator carrying the third wire. This odd construction was adopted to get sufficient ground clearance and still use 35 ft. poles, the cost of poles being high in this country, and this device being less costly than a longer pole. This line after leaving the power plant crosses the Owens valley ascending the slope of the White Mountain range bounding this valley on the east, and crossing the summit through a pass at an altitude of over 9000 ft. Several desert valleys and ranges are crossed in a general northeasterly direction until, at a distance of 51 miles from the generating plant the switch house at Palmetto is reached, thence 17 miles to Silver Peak substation and switchhouse and thence continuing a further distance of 18 miles to the Alkali sub and switching station. From this point the line divides, one branch going to Goldfield and the other to Tonopah.

From the power house to Alkali the circuit is a No. 0, 7-strand aluminum conductor. The insulators are Locke No. 352 and have been tested to 90,000 volts. The conductors are placed in an equilateral triangle with reference to each other, the sides of which are 6 ft. The poles are spaced 17 per mile. There are a few spans, the longest of which is 475 ft. The Goldfield line from Alkali has a length of 9 miles and the conductor is No, 2, 7-strand aluminum. The Tonopah branch has a length of 18 miles and is similar to the main line to Alkali.

New discoveries of gold at Bullfrog and Rhyolite, about 80 miles south from Goldfield was the cause of great excitement in the year following the construction of the first line, and in 1907, in response to a demand for power in those districts, the transmission



Substation and Arrester House at Goldfield.
Substation at Millers.
Switch House and Substation at Alkali.

Substation at Tonopoh.

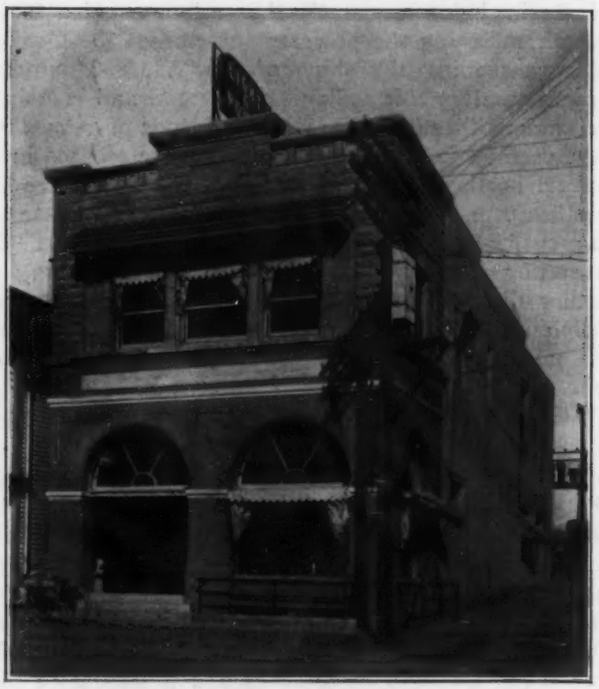
was extended from Palmetto switching station to Rhyolite, a distance of 73 miles. This line is also similar to the first line built.

In the following year, the line first built was loaded to its capacity and a second circuit was constructed from the power house, through the Palmetto station to Silver Peak and an extension was built to Millers a distance of 30 miles. The new line differs from the old in that the circuit is of No. 2, 7-strand aluminum, and the poles are framed in the usual manner, not using the "U" shaped channel, and with the top pin at the top of the pole, otherwise these lines are similar. The line from Silver Peak to Millers carries a circuit of No. 0, 7-strand copper. In 1909 an extension was built from Millers to Manhattan, another mining town which had a spectacular development just before this time.

The distance of transmission from San Bernardino over the Southern Sierras system and thence over the lines of the Nevada-California system to Rhyolite is just 400 miles and recently these lines were so tied together and operated at 55,000 volts potential, the power being supplied from the San Bernardino steam station. This parallel operation of these systems worked very satisfactorily.

Nevada-California Company's Substations.

The Palmetto switch house, at which point the line to Rhyolite branches is a steel frame building covered with corrugated iron. The floors are concrete and the high tension switches are placed on elevated reinforced concrete platforms suppored by steel columns similar in manner described for some of the power plants.



Nevada-California Power Company's Nevada Headquarters at Goldfield.

The main lines after entering the building connect to a cross bus through single pole disconnecting switches.

Substation at Manhattan, Nevada.

The lines leaving the house are each controlled by Pacific Electric Manufacturing Company oil circuit breakers. The Rhyolite line is controlled by a Kelman 60,000 volt automatic circuit breaker. The outgoing lines are also equipped with single pole disconnectors. A cottage for an attendant adjoins this station and the surrounding plot of ground has been carefully planted with shrubs and trees. A view of this station shows well the nature of the surrounding country.

Type of Home Built by the Companies for Operators.

The substation and sectionalizing house at Silver Peak is corrugated iron over a steel frame. The entering lines are equipped with Pacific Electric air-break switches and Siemens horn-gap lightning arresters are connected to these circuits between the switches and the station building. One of the circuits leaving this station continues, supplying Alkali and thence Tonopah and Goldfield, while the other extends to Millers. There is also a 6600 volt circuit from this station which supplies the Silver Peak Gold Mining Company's property a distance of 5 miles at which point current is supplied for operating a large gold mine and mill. This circuit also supplies a lighting system in the town of Blair. The substation contains three 500 kw. Westinghouse self-cooling oil insulated transformers, equipped with auxiliary water cooling coils for overload or extreme heat conditions. The local distributing voltage is adjusted by means of a three-phase hand controlled voltage reguiator. Outside of the building is installed a set of General Electric 55,000 volt electrolytic lightning arresters.

The alkali station is a reinforced concrete building in the style followed in the power houses. The Tonopah and Goldfield lines leave the building from opposite gables, while the main line enters at the side. On each of the branch lines, before leaving the building, are installed a set of Kelman oil circuit breakers. There are also in this station three 50 kw., 55,000 to 6600 volt lowering transformers. These supply power to pumping plants in the immediate vicinity. In a separate building are a set of General Electric electrolytic lightning arresters.

The Goldfield substation, the first to be built on this system, is a very substantial stone building. Its location is on the outskirts of the city somewhat north of the main business section at a point convenient as a center of distribution to the power business which developed rapidly upon its installation. The main line enters, after passing through choke coils mounted on a pole, through Kelman oil circuit breakers to which connection is made to a bus line extending throughout the length of the interior of the building. The transformers placed on the main station floor are supplied directly from the high tension bus. There is one bank of three 500 kw., Stanley-G. I. self cooled, 55,000 to 6600 volt lowering transformers, and a second bank of three 750 kw., General Electric transformers of the some voltage ratings. All of these transformers are supplied with auxiliary water cooling coils, to maintain safe temperature conditions during hot weather or overloads. The water for cooling is circulated through a cooling tower and thus is used over and over again. Near the main substation building is a reinforced concrete arrester house which contains a set of General Electric 55,000 volt electrolytic lightning arresters. Line connection to these arresters is made in the conventional manner through horn gaps. There are three 6600 volt circuits passing from the substation, two of these supplying power for mining operations and a city

service for Goldfield, while the third supplies Diamondfield and the district surrounding. A General Electric arc regulator set in the substation supplies a street lighting circuit for the city of Goldfield.

The substation at Tonopah, also one of the first to be constructed, is quite similar in style to the Goldfield station. The transmission line branching at the Alkali switching station, enters the building after passing a Pacific Electric outdoor type switch, thence through disconnectors within the building, connection is made to a cross bus. A transmission circuit from the Millers substation enters the opposite side of the building and in a similar manner to the one already described, and connects to the cross bus, through disconnectors. A Kelman oil circuit breaker in the bus line connects both ends and thus permits the paralleling or separating of the two main transmission lines, it being therefore possible to supply this station either direct or via Millers or both. There are installed in this substation three 300 kw. and three 500 kw., Stanley-G. I. 55,000 to 6600 lowering transformers, and a bank of three 500 kw. Westinghouse transformers of the same voltages. These transformers are all self-cooling but are equipped with water circulating coils to be used in the prevention of excessive heating. Following the recent practice of this and the allied company, the latter set of transformers have been equipped with weather proof covers and entrance bushings and will be placed outside of the station. Eventually all of the transformers will be so equipped and placed leaving the building to be used for switching purposes and as a dwelling for the operators. Four distributing 6600 volt circuits from this station cover the adjoining territory several miles in radius and supply, not only power to mining plants but also light and power to the city. An arc lighting system similar to the Goldfield system is installed here.

At Millers the substation is of corrugated iron over a steel frame. The line from Silker Peak enters one end, passing through a Kelman non-automatic oil circuit breaker, while from the other end is taken the line which goes to Tonopah a distance of 18 miles. A set of Siemens horn gap arresters is installed near the building while within is a set of General Electric electrolytic arresters. There are at this point three 500 kw. Westinghouse, self-cooling lowering transformers, with 55,000 volt primary and secondary giving 6600 and 2200 volts, equipped with auxiliary cooling coils. A branch transmission line to Manhattan 34 miles, is controlled by a Kelman automatic regulator. The local distribution from this substation supplies the reduction works of the Tonopah Milling Company, the Belmont Milling Company and an ore sampling plant, these works handling a large part of the output from the gold mines of the Tonopah and Goldfield and numerous other mining districts.

The substation at Manhattan is of reinforced concrete in the style of the power house buildings and makes a neat and artistic appearance. Within this station, besides a set of General Electric electrolytic lightning arresters is a bank of three Stanley-G. I. 300 kw. self-cooled transformers of the usual voltage ratio of 55,000 to 6600 volts. From this station two 6600 volt circuits supply the immediate surrounding locality. The third circuit extends to Round Mountain, a distance of 13 miles supplying mines and mills in that district. A line voltage of 11,000 is used on this circuit and this is obtained through a star connection of the 6600 volt secondaries of the lowering transformers. The lower voltage conections are taken from taps in the secondary windings.

The remaining substation is at Rhyolite and follows the general plan of construction which has been consistently adapted in this system.

The Nevada headquarters for this system is at Goldfield where a two-story building of concrete blocks with a cement covering contains the various offices. On the lower floor is a well equipped display room and the cashier's and superintendent's offices. The upper floor is devoted to the offices of the various departments.

The writer is particularly indebted to Mr. C. O. Poole and Mr. R. G. Manifold engineers for the Southern Sierras Power Company for their assistance in gathering data for this and the preceding article, and to many others in the employment of the company for courtesies shown.

CO-OPERATION IN THE CORPORATION.

BY M. H. GREGG.[1]

Corporation and co-operation are two words that sound similar. They are not only alike phonetically, they are inseparable from the standpoint of modern business ethics. Co-operation may exist without corporation, but corporation can only exist through co-operation. As a proof, consider the working organization of a corporation. We all realize the necessity for an organization of men to handle all large business interests. There are a great variety of problems with which to deal, and it is just as impossible for one man to be able to solve each one of the problems in all its ramifications as it would be for one man, in modern days, to constitute a whole government.

This limitation of individual ability is especially noticeable in our modern public utility corporation. We need men in our organizations to perform a very wide range of work, such as executives, salesmen, technical engineers, practical engineers, office help of varied experience and plain laborers. It is necessary where such a number of men are working for a common interest, to have them divided into groups or departments headed by officers or department heads. An officer or a department head is a man who is supposed to know more than the men under him do about the work in general. It is always safe to assume that the man above knows more about the business than his subordinates. If he doesn't, he will not remain above them very long. Anyway, the assumption will not cause a subordinate any harm and may save him much trouble. There are very few cases where officers or department heads have received their appointments when not merited.

Now, if we analyze the departments, we find that different personalities are necessary for their successful make-up. Where you find a department containing opposite natures under the control of an officer, you will usually find a department which

[1]Division Manager United Light & Power Company, Oakland, Cal.

is very effective in its work. Having seen that the individual is so important in the corporation's life, it follows that each man's views should be given consideration. No employe of a corporation should hesitate to give his views of the corporation's affairs arising in his department. He should support these views with facts and work hard for their adoption. If his views are accepted, he is the gainer. If his views are not adopted, he has lost nothing. How can a corporation that depends upon an organization, in which so many different types of men are needed, make any progress unless there exists among these men a spirit of co-operation; a spirit of helpfulness? Co-operation is the electricity which runs the motor corporation. It is generated by broad-minded action. Its generator must be in phase with the current in the primary line of mutual interests, before its output is of value in mingling with that of the other generators working on the line.

If co-operation is necessary for the success of the corporation, it follows it must be necessary for the success of the individuals composing the corporation. How can one best employ this spirit? If, as mentioned before, he has expressed his views on corporation affairs under advisement and has seen these views discarded, then he must subdue his own opinions regarding the performance of certain work assigned to him, because his opinions are in conflict with those of the man above him in authority, and he must throw his whole energy into an endeavor to bring success to the adopted plans. He has then overcome the greatest and practically only stumbling block in the path of co-operation. That sounds like an easy task, but its performance seems to be the most difficult thing a man has to accomplish. The period following the adoption of views at variance with his, is the critical period to which each man should give careful attention, and be very guarded in his actions. This period is fraught with danger. The danger arises in not being able to forget one's own views; in bearing animosity toward the views which have been adopted by the superior officer; and not rendering his combined efforts toward bringing success to the adopted views. Therein lies a test of character and it is a most severe one, simple though it seems, but it pays to accomplish it and to do so is absolutely necessary for the ultimate success of the individual. If one pursues the contrary method and does not render himself wholesouled to the task before him, or if he throws obstructions in the way, he is courting instant death, literally speaking, and if not fortunate enough to meet it at once and be resurrected to common sense, he will continue in a path that will surely lead to oblivion.

Business is based upon selfishness, that is we are only in business in order to gain something. When men enter business, they are selfish. In other words, they desire to gain something such as wealth, fame or the necessities of life. Now these are not, for one minute, to be considered as bad motives. On the other hand, they are good, because if it were not for the selfishness in business, there would be no incentive for industry and, we would not be an active and progressive race. Realizing that selfishness is the proper spirit to have in business, we must not overlook the fact that there is a limit to this selfishness as there is a limit to all actions, either good or bad. He is wise who knows his limit in everything. History is full of names of rulers, generals, statesmen and men of all walks of life who have failed to stop before they reached their limits. The limit in business selfishness, beyond which one must not go and which one must not reach, is the point where antagonism and animosity begin. Stepping into a friend's office one day several years ago, I read a motto which hung on the wall. Although I do not care much for mottos, this one impressed me as being very good and a realization of its import did me more good than anything else in the motto line. It read, "He who plots another man's undoing is plotting his own." Think about this and recall the examples that have come to your attention and see what your views are regarding its value. Personally, I have yet to see the example that disproves the truth of this motto. If the other fellow does not co-operate with you, let him alone. Do not antagonize him nor try to undermine him. Watch yourself, however, to see that you co-oporate with him when the opportunity presents itself. It is hard enough to get along in the business world now-a-days without being pestered with position-destroying fellow workers. The competitor outside the line keeps you sufficiently busy. Give every man a chance to succeed. If he is under you, give him help and do not strew his path with stumbling blocks, nor set traps to destroy him. If he is over you in authority, respect his views and obey his orders, no matter what your views are. In other words, co-operate. In so doing, you will first further the interests of your corporation, and secondly will protect your own interests. You enter business to accomplish the latter. The corporation employs you to do the former. Two interests have been served. Dividends are forthcoming, and a pay check appears regularly.

EXTENSION OF ELECTRIC POWER IN SOUTH AFRICA.

Great progress was made during the year by the two large electric power companies which supply motive power to a majority of the leading Rand gold mines and which, as a consequence, are closely allied to the gold mining industry. These are the Victoria Falls and Transvaal Power Co. (Ltd.) and the Rand Mines Power Supply Company. These companies, operating together, now have four large generating stations situated at Brakpan, Simmer Pan, Rosherville and Vereeniging, also a station at the Robinson Central Deep mine for generating compressed air. Additional plants have been ordered as follows: Two 11,000 kilowatt turbines at Simmer Pan; two 12,000 kilowatt turbines at Vereeniging; three 7000 kilowatt steam driven turbo air compressors at Rosherville station. When these are installed the combined capacity of all the power stations will be 140,000 kilowatt electric plant and 61,500 kilowatt air compressing plant. In addition to the above, further new construction is contemplated in connection with the Brakpan station to meet the demands of the developing gold fields of that district.

ELECTRICAL PUMPING AND IRRIGATION

STRUCTURES FOR THE DISTRIBUTION SYSTEM.

BY B. A. ETCHEVERRY.

The structures used for the distrbution system are:

1. Check gates to control or raise the water in the supply canal to divert the water into one or more branches or through an escape.

2. Headgates or turnout gates at head of canals or laterals.

3. Division boxes on small laterals or farm ditches.

4. Measuring boxes at head of private ditches.

5. Wasteways, escapes or spillways located at drainage channels.

6. Drops or rapids.

7. Drainage crossings: flumes, siphons, culverts, level crossings.

8. Road crossings: bridges and culverts.

The last four groups of structures differ only in size from those used on the main canal. These have been previously discussed and will not be considered any further. The first four groups include those types of structures which either belong only to the distribution system or differ more or less from the types of structures used on the main canals. The structures used on the distribution system are very numerous. To simplify their design and construction it is generally advisable to prepare standard designs as far as possible.

Check Gates.

Check gates are used when it is necessary to raise the water level in the canal to divert it into one or more branches or through an escape or wasteway upstream from the check gate. The use of check gates favors the deposition of silt and increases the seepage losses, hence it is desirable to use as few as possible. When the slope of the canal is flat and the branches not far apart, the use of one check gate may be sufficient to raise the level of the water to divert it in more than one branch. A check gate is often built in combination with the lateral headgate for which it raises the water surface. The check gate is usually at right angles to the lateral. On the smaller laterals or distributaries the check gate with the lateral headgate form what is more commonly called a division box. A check gate is often necessary at a wasteway and is built in combination with that structure. Examples of this form of construction are the Umatilla sand gates and Amity Canal wasteway and sand gates previously described. Drops are very frequently used as check gates by providing gates or flashboards to close the openings above the crest of the drop.

A check gate structure usually consists of a rectangular channel formed by a floor, side walls, wing walls and cut off walls, divided into one or more gate openings. The gate openings are separated by piers or columns and closed with flashboards or life gates. On the main canal of large irrigation systems the design of check gates is very similar to that of headgates.

The cross sectional area of the channel of the check gate should be made very nearly equal to that of the canal section in order to prevent the occurrence of eddies at the inlet and outlet. A simple type of check gate is the following:

The check gate on the Pawnee canal consists of five openings each five feet wide regulated by means of flashboards supported on concrete piers. For flashboard guides an iron bar is partly imbedded in the upstream face of the concrete pier. The piers rest on a reinforced concrete floor 4 in. thick. The piers and

Culvert Gate on Farm Lateral With Taintar on Radial Gate—University Farm, Davis, Cal.

side walls are also 4 in. thick and support a footwalk 18 in. wide and 2 in. thick. The vertical aprons on the upstream and downstream end extend 3 ft. below the grade of the canal. The cut-off walls on the two sides extend well into the banks and act as buttresses to the side walls and are tied to each other by a 4 x 6 in. concrete beam reinforced with two ⅜ in. rods. The floor, walls, piers and footwalk are reinforced with 26 in. hog wire netting. The structure represents a very good type of check gate and requires only 8¼ cu. yds. of concrete. The carrying capacity of the canal is 200 second feet.

Lateral Headgates and Takeout Boxes.

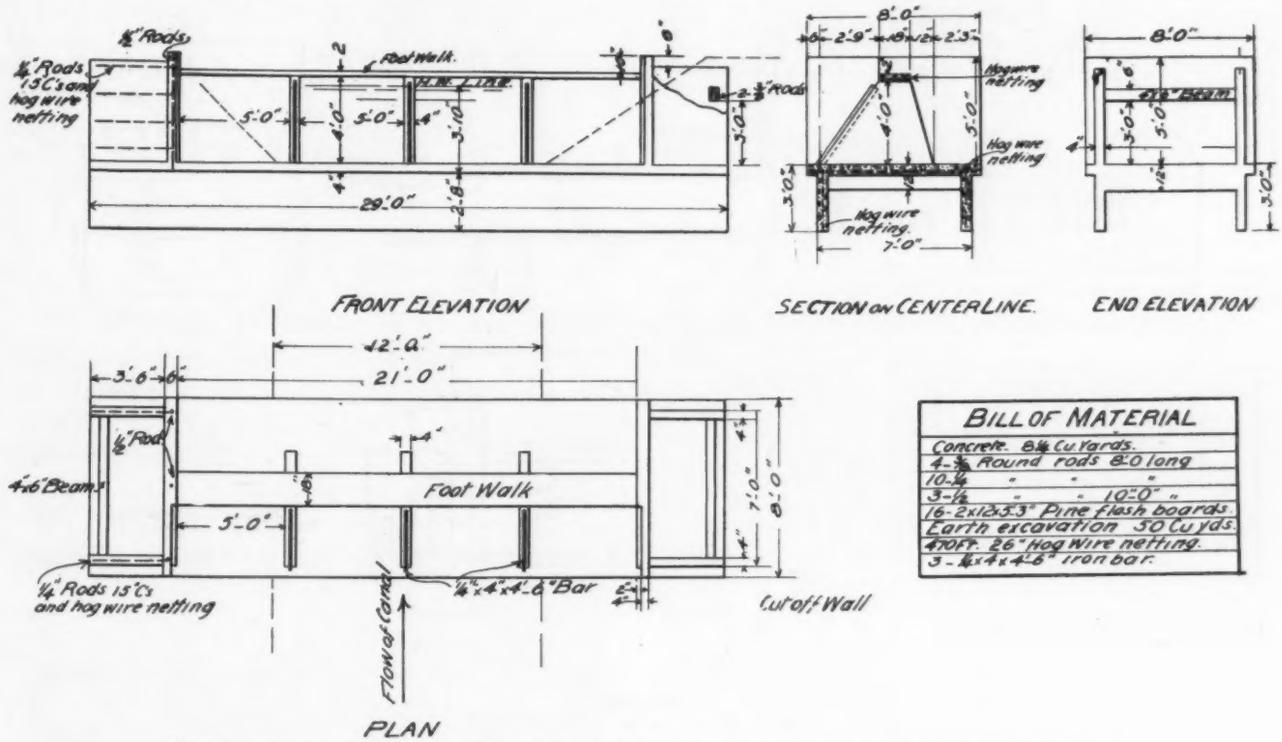
A lateral headgate is necessary at the head of each lateral to regulate the flow in it and at the point of delivery to each farm. On large systems the lateral headgates for the main laterals are frequently of the same type as the headgate of the main canal at the headworks, differing only in size. For the smaller laterals two types are in common use; the culvert type and the open cut type.

The first type consists of a pipe or rectangular box built through the embankment with suitable inlet and outlet. The inlet is regulated with a slide gate and requires a lifting device for the larger sizes. The inlet is generally formed with wings but in some cases consists simply of a concrete protection or collar built around the inlet end of the culvert. The upstream face of the collar may be formed on the same slope as the canal bank and a sloping gate used. The outlet is formed with wings and a floor or may be replaced by a measuring box.

The second type consists of a rectangular chan-

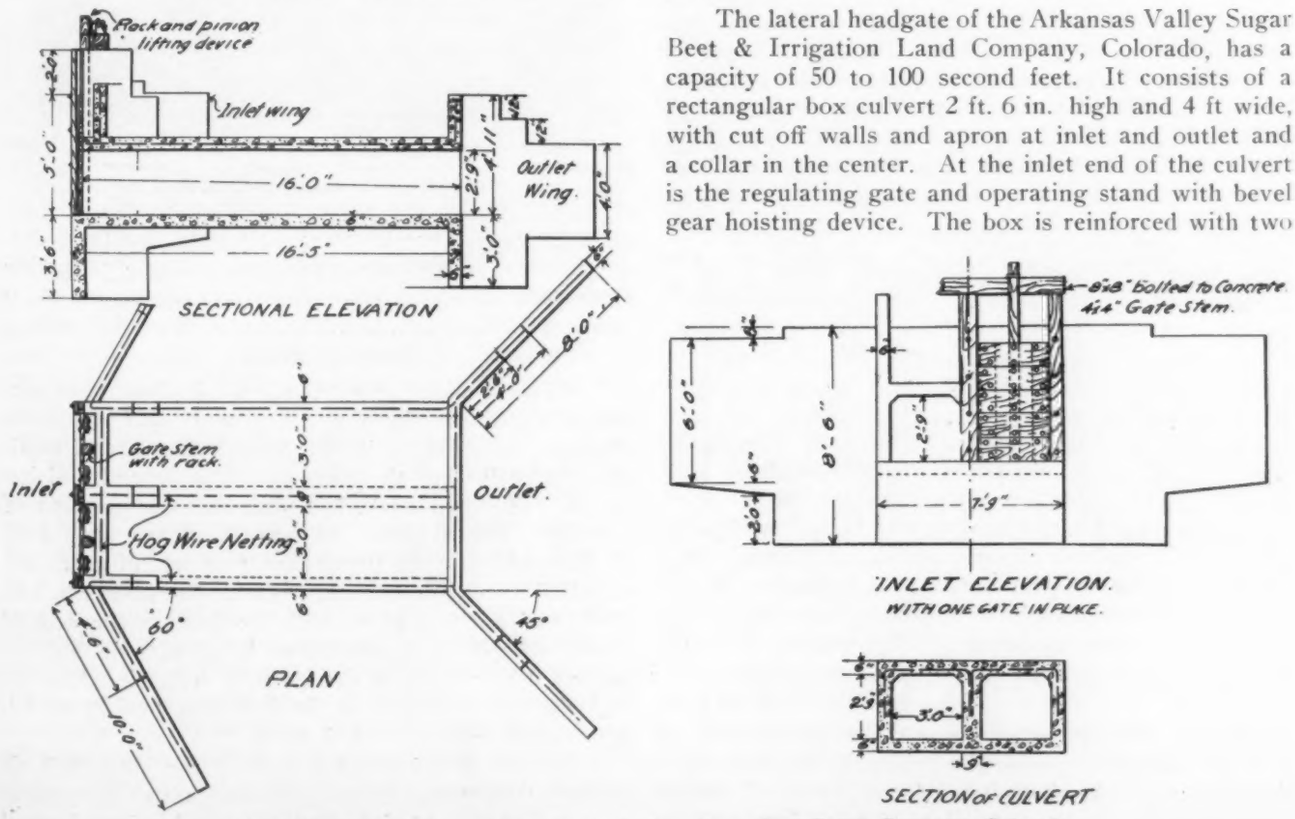
nel or short flume section built in an open cut in the canal bank. The inlet is formed with wings or cut off walls and the outlet is made as the inlet or replaced with a measuring box. The channel may be divided into two or more openings and these are regulated usually with flashboards or simple lift gates. The floor of the takeout box or headgate must be sufficiently low with respect to the bottom of the supply canal to allow the desired volume of water through it when the canal is running partly full. Often the floor of the box is made 6 in. lower than the bottom of the canal.

The first type is preferable where the bank of the canal is to be used for a roadway and it is usually more economical for small volumes of water. Examples of the first type are given below.



Check Gate in Pawnee Canal—Arkansas Valley Sugar Beet and Irrigated Land Company.

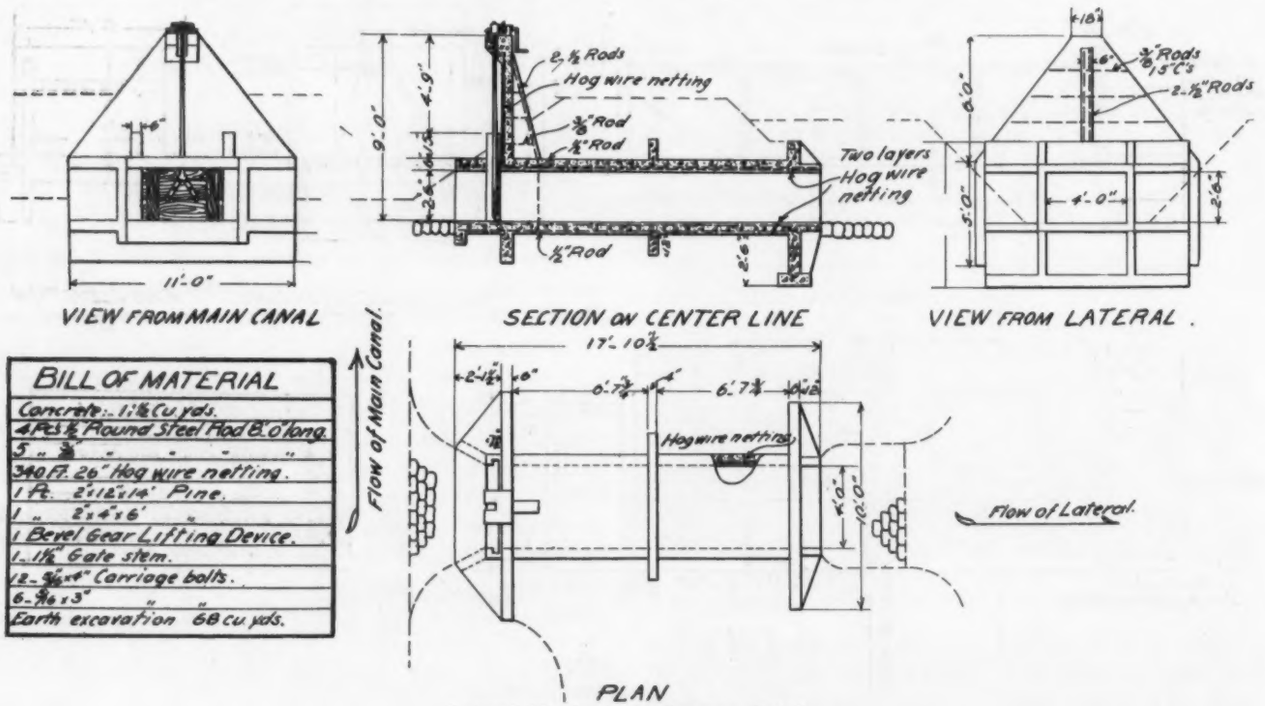
The lateral headgate of the Arkansas Valley Sugar Beet & Irrigation Land Company, Colorado, has a capacity of 50 to 100 second feet. It consists of a rectangular box culvert 2 ft. 6 in. high and 4 ft wide, with cut off walls and apron at inlet and outlet and a collar in the center. At the inlet end of the culvert is the regulating gate and operating stand with bevel gear hoisting device. The box is reinforced with two



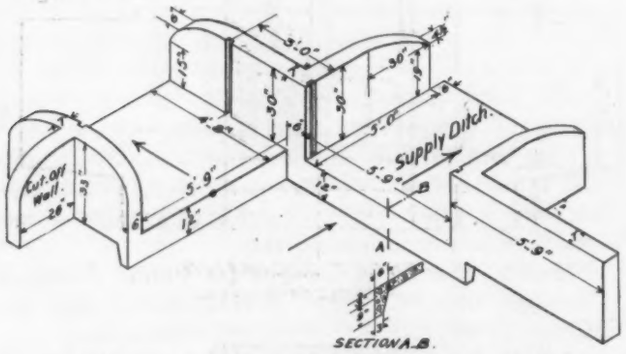
Lateral Headgate for Carlton Lateral—American Beet Sugar Company, Colorado.

layers of hog wire netting. The wall of the operating stand is reinforced with hog wire netting and ⅜ in. rods. The buttress to this wall is reinforced with two ½ in. rods. The structure contains 11.5 cu. yds.

The lateral headgate for the Carlton lateral, American Beet Sugar Company, consists of a rectangular concrete box culvert 16 ft. long with inlet and outlet wings and wooden gates at the inlet. The cross section of the box culvert consists of two openings each, 3 ft. wide by 2 ft. 9 in. long, separated by a center concrete wall 9 in. thick. The floor, roof and sides are all 6 in. thick. The culvert box is reinforced with wire netting placed in the roof and extending part way down the side walls and center wall. The inlet wings are 10 ft. long, 6 in. thick, and reinforced with wire netting. The wings make an angle of 60 degrees with the axis of the culvert and extend 3½ ft. below the grade of the canal which prevents undermining. The outlet wings are 8 ft. long, 6 in. thick, and reinforced with wire netting. The wings make an angle of 45 degrees with the axis of the culvert and extend 3 ft. below grade. At the gate end the side and center wall of the box culvert are stopped up and act as buttresses to the front wall and also support the lifting device. The gate frame is made of lumber and securely bolted to the concrete. The itemized cost is given below. The concrete was a mixture of about 1 part of cement to 6 of gravel. The structure contains about 15 cu. yds. of concrete. Cement cost about $1.45 a barrel. The average cost of the concrete in place is about $10.50 a cu. yd.



Lateral Headgate in Pawnee Canal.



Division and Check Box—Turlock Irrigating District.

Cost of Lateral Headgate on Carlton Lateral:

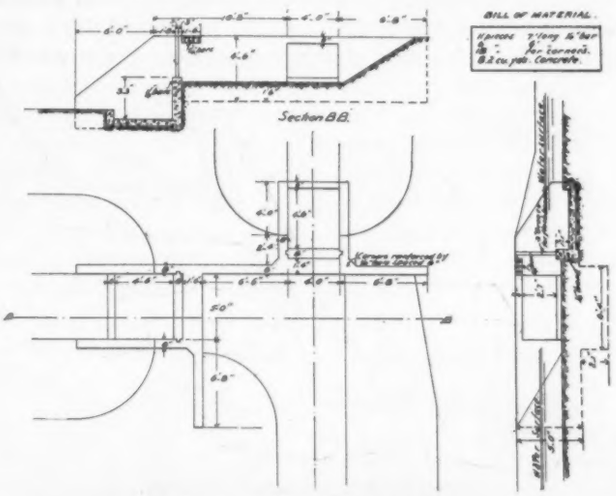
	Concrete. 15 cu. yds.	
Labor:		
Excavating, men and teams	$13.60	
Carpenter work on forms	13.00	
Screening gravel	8.23	
Hauling gravel, men and teams	21.30	
Mixing and placing concrete	19.50	
Blacksmith, making bolts	1.00	
Miscellaneous	13.35	$89.88
Material:		
67 bags of cement	$24.58	
Lumber at half value	6.25	
Nails	.45	
Bolts	.89	
Wire netting	1.63	
Cement for plastering and patching	.15	33.95
Engineering:		33.59
Total		$157.42

Division Boxes.

Division boxes or gates are used where it is necessary to divide the water between two or more ditches. While there is usually only one lateral headgate for each form, there are generally several division boxes. The division box is placed at the junction of two or more ditches. Where there are only two ditches, which is the usual case, two sets of gates are required; one to check and regulate the flow into one ditch and another to control the flow in the second ditch. Simple types of division boxes are the division box used on a farm in the Turlock Irrigation District and the division box on the Umatilla project which combines a turnout and drop.

The division box on a farm in the Turlock Irrigation District was built by the irrigator. It consists of two openings at right angles to each other, formed

with side walls and floors in between. The supply ditch runs in the direction indicated by the arrow and the branch runs at right angles. On the upstream side of the floor a cut off wall or apron extends 12 in. below grade. To prevent washing around the structure a wing wall 5 ft. 9 in. long extends into one ditch bank and a cut off wall 26 in. long is built in the other ditch bank. The flow of water is controlled by flashboards placed in the grooves of the side walls. The



Lateral Turnout and Drop or Division Box—Umatilla Project, Oregon.

box is made of plain concrete but could have been made stronger by placing some reinforcement at the corners. The concrete used consisted of 1 part of cement to about 6 of sand. The forms were made in sections hinged at the corners and have been used for making several of these boxes. About 2 cu. yds. of concrete are required for one box. The sand was very close at hand. The structure in place was built for about $10 exclusive of the forms.

The division box or turn out on Umatilla project is a combined turnout and drop box and is used to regulate and divide the flow between two laterals which have a maximum carrying capacity of 20 to 30 cu. ft. per second. The structure consists of two openings formed between side walls controlled with flashboards inserted in the grooves of the walls and operated from the footwalks. The retaining wall of the drop and the two footwalks are reinforced with ¼ in. bars; the remainder of the structure is made of plain concrete. The total amount of concrete required was 8.2 cu. yds. While the cost of this structure was not obtainable, the itemized unit cost of 83 similar small concrete structures aggregating 93 cu. yds. was as follows:

	Unit cost per cu. yd.
Hauling material (including cost of gravel)	$7.53
Mixing and placing concrete	5.98
Making forms	4.52
Matelial: Lumber $2.69, cement $2.39	5.08
Total	$23.11

The concrete was composed of 1 part cement to 3 of sand and 4 of gravel. The unit cost is very high and under more favorable conditions should be less than half the cost given.

CLASSIFICATION OF EXHIBITS FOR DEPARTMENT OF LIBERAL ARTS, PANAMA-PACIFIC INTERNATIONAL EXPOSITION.

The following groups show the classification which will be given exhibits for the Department of Liberal Arts at the Panama-Pacific International Exposition in 1915:

Typography—Various Printing Processes, (the equipment, processes and products), including engraving, lithography, typesetting and distributing, typewriting, dictating and addressing machines, mimeographs, etc.

Books and Publications—Book Binding, (the equipment and products), including newspaper and magazine offices or plants, methods of advertising, special libraries, musical scores, etc.

Maps and Apparatus for Geography, Cosmography, Topography—including globes, nautical almanachs for astronomers, surveyors, etc.

Manufacture of Paper, (the raw materials, equipment, processes and products).

Photography, (the equipment, processes and products),—commercial and pictorial, including stereopticons, moving pictures, etc.

Instruments of Precision, Philosophical Apparatus, Coins and Medals, (the equipment, processes and products),—including telescopes, surveyors' and navigators' equipment, optical goods, calculating machines, cash registers, scales, weights and measures, etc.

Medicine and Surgery,—including anatomical models, dental, druggists' and veterinary equipment, X-ray apparatus, artificial eyes and limbs, hospital equipment, etc.

Theatrical Appliances and Equipment,—including arrangements for preventing and extinguishing fires.

Electrical Methods of Communication—including telegraphy, telephony, fire alarms, police signals, etc.

Civil and Military Engineering,—including lighthouse equipment, harbor safeguards, military defenses, water works, sanitation, production of artificial stone, methods of testing materials, etc.

Models, Plans and Designs for Public Works,—including construction, etc., of roads and streets, inland navigation, bridges, subways, tunnels, etc.

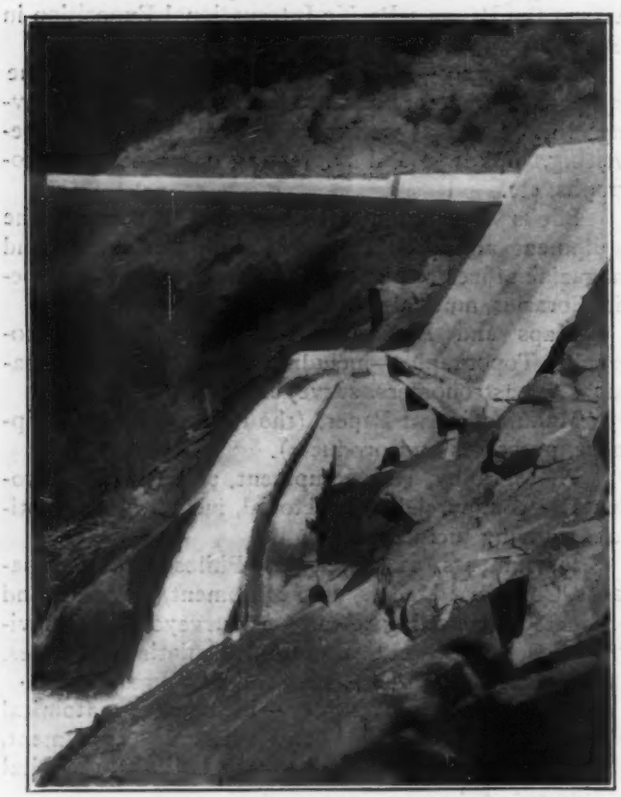
Architecture,—Including mosaics and decorative details, etc.

Architectural Engineering—including safety devices, etc., in passenger elevators, fire escapes, ventilators, etc.

SIPHON SPILLWAYS.

BY C. F. ADAMS.

The use of concrete for flumes has modified other plant details such as head gates, spillways, etc., and has led to the partial adoption of the siphon type of spillway. The relative value of the spillway as a plant feature is largely determined by other plant characteristics. The nature of the load, whether constant or fluctuating; the use or absence of a terminal reservoir; the type of nozzle employed, whether deflecting or rigid with needle valve control; these are all factors that affect the spillway requirements. Where the flume line or ditch crosses and receives water from small canyons, such points must have provision for wasting water during storm periods and disposing of drift materials. Where soil and rock formation above the ditch line are subject to slippage, provision should exist for protection from such accident.

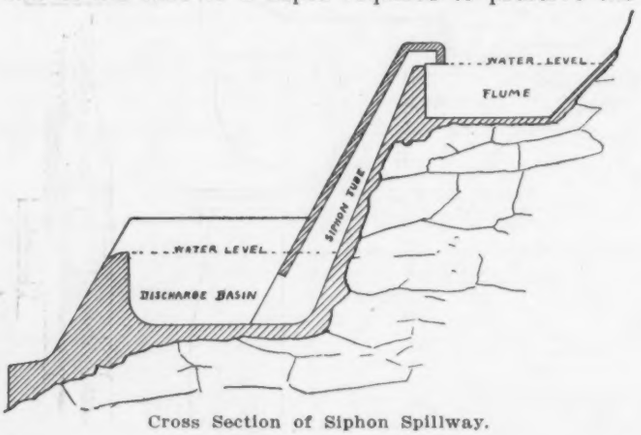


Concrete Siphon Spillway Mt. Whitney Power & Electric Company.

For a plant of small capacity, provided with terminal reservoirs and deflecting nozzles, the spillway problem is simple as the spillway is seldom in use. For the larger installation, where the water conveyed amounts to more than one hundred cu. ft. per second and the flume discharges into the pipe line without a regulating reservoir, then the spillway becomes a vital and essential feature of the plant.

The average operating head found in Pacific Coast plants is about eight hundred feet and the complete discharge of a full flume down the steep mountain side requires a carefull selection of spillway location if excessive erosion is to be avoided. Where an open spillway might require a discharge length of one hundred feet with an overflow of four inches, a siphon will concentrate this discharge into one-tenth this space. With this reduction of spillway space, the flume may be discharged over any convenient rocky point that offers the condition of minimum erosion.

A properly designed siphon tube is similar in its proportions to a turbine draft tube. The tube is slightly conical in form, expanding toward its base, and the velocity of the discharge water is low whatever the height of the tube. The discharge outlet must terminate in a receiving basin that will submerge the lower end of the tube to a depth required to preserve the



Cross Section of Siphon Spillway.

vacuum. This water seal in depth, should approximate eight per cent of the vertical drop of the tube. The maximum possible inlet velocity of the water is that due to an air pressure of 14.7 lbs. per sq. in., which would produce a water velocity of forty-three feet per second. This condition would be approached in a siphon in which the water level in the discharge basin was thirty feet below the water level in the flume during siphon operation. In practice the velocity is limited by the form and area of the entry opening and also by the friction of the tube walls. For safe capacity design, a maximum entry velocity of thirty feet per second may be assumed for tubes thirty feet in height.

The curve of water velocities under different heads also indicates the theoretical inlet velocity of water with siphon tubes up to thirty feet in height. This curve indicates clearly that the most efficient height of siphon tube is much less than thirty feet and good working results are obtained with a height of twelve to sixteen feet. For small flumes or for flood water relief siphons, a height of but six feet gives excellent service.

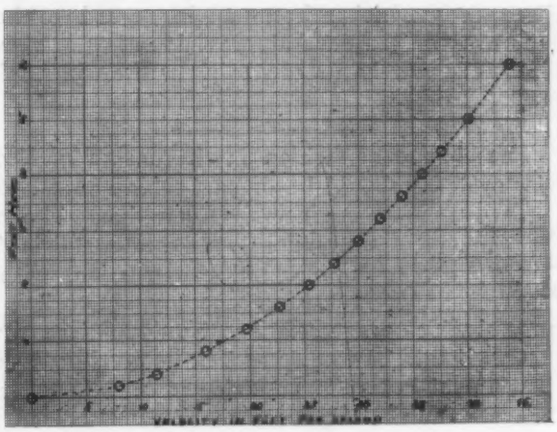
For easy construction and the economical use of materials, a siphon of large capacity should be built in sections, using a number of oblong tubes whose width should not exceed five feet. These tubes would be separated by vertical partitions that will support the strains due to air pressure. The tubes should be given a smooth cement finish in order to reduce friction and also to close any porous surface that might admit air. The entire siphon structure should be mounted on solid rock foundation and should have a solid rock spillway. In the absence of such conditions, a protective footing of solid concrete masonry must be laid to prevent the discharged water from undermining the entire struc-

ture. The entire construction must remain solid and permanently free from cracks and for this reason reinforcing materials should be liberally used.

The removal of wood forms from the siphon tubes is best accomplished by filling the forms only to the water entrance level with the reinforcement in place. When this concrete is firm remove the tube forms, finish the tube wall and then pour the upper section.

To be entirely dependable, the operation of the siphon must be independent of any mechanical operating device. When the flume water reaches a certain level, the siphon must act and remain in operation until the water is lowered to the required level. To obtain rapid and certain action from a siphon, a certain amount of "charging" water must be allowed to flow to fill the lower basin, seal the discharge outlet and then exhaust the air from the siphon tube. The depth of this stream determines the time required for full operation of the siphon. This charging stream for average operation, should have a cross section equal to one-fifth the area of the entry opening, and in the design shown this stream would be two inches in depth.

The question is often asked, "How can a small stream of water flowing down a smooth inclined tube, remove enough air to produce an operating vacuum?" Observation of the action of the siphon indicates that the air becomes engaged by the falling stream, particularly at the base of the stream, and is driven out beneath the lower lip of the siphon, appearing in streams of bubbles that rise out of the discharge basin. The discharge of air increases with the increase of stream flow and several minutes may elapse before the final vacuum and the maximum flow of siphon is reached. The larger the tube, the slower the complete action. The siphon will continue in action until the water level of the flume falls below the entry lip and admits enough air to relieve the vacuum in the tube. There



Curve of Water Velocity Under Pressure.

is considerable surface agitation of the flume water at this time, the siphon taking in water in huge gasps, making and breaking the discharge which finally ceases when the flume water level is about an inch below the entry lip.

Owing to the relatively small opening of the inlet, it should be protected against the lodgement of drift wood by some form of screen. When constructed in localities that are subject to freezing, the discharge basin should have a substantial drain. The dam which closes the front of the discharge basin should conform to standard profiles, with a smooth rollway and an apron extension at the foot. The crest of dam should be wider than the ordinary design on account of the velocity of the discharge water. The receiving basin should have a length at least four times the depth of the siphon tube at its base. These provisions will insure relatively still water in the basin which is essential to the best operation of the siphon.

The discharging siphon shown in the illustration is the first of this type to be installed on the Pacific Coast and its performance has justified its owners, the Mt. Whitney Power & Electric Company in the construction of this interesting type of spillway.

EXPANSION IN ELECTRICAL INDUSTRY IN GERMANY.

The demands caused by the ever increasing use of electricity in almost all walks of industrial life have served to keep the German manufacturers of electrical products unusually busy. In comparison with the prosperity throughout all branches of the German electrical industry during the two previous years, the conditions during 1912 were even more favorable. The improvements made in the generation of electricity and in the means for its transmission by which the current can be furnished to consumers at lower rates have tended to increase greatly the number of overland central stations that have been erected during the past few years for supplying cities, towns, communities, and individual land owners with electric current for light and power purposes.

The German manufacturers during the year received large orders for electric cooking and heating apparatus, for heavy electrical machines, transformers up to 15,000 kilowatts, with a tension up to 110,000 volts, railway signal and safety apparatus, high tension cables, turbines, apparatus for the electrochemical industry, especially for the extraction of nitrogen from the air, and for the ozonation of the water supplies of cities, electric welding apparatus, generators for coupling to gas and Diesel motors, up to 6000 horsepower, electric equipment for submersibles, electromedicinal apparatus, electric cables, insulating materials, etc.

PRICES FOR ELECTRICAL GOODS IN GERMANY.

The prices obtained for German electrical material in 1912, with the exception of those for turbines and metal filament lamps, were on the whole more favorable than during the previous year, but notwithstanding the improvements in the processes of manufacture they could not be kept on a parity with the increased costs of production. The financial results for 1912 were good, as evidenced by the fact that almost all the German electrical companies were able either to increase their dividends or to maintain those declared during the previous year. To meet the ever-growing demands of the electrical industry both of the larger companies were compelled to raise their own capital stocks and in some instances those of their subsidiary concerns.

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Federal Water Power Policy

Secretary Franklin K. Lane of the Department of the Interior is showing a more conciliatory attitude toward the hydroelectric power companies than did some of his predecessors. Last week he made preliminary announcement of the administration's policy as to the disposition of the government's water rights. While the requirements are still too rigid to attract capital from the ordinary investor, yet it is the spirit more than the letter of the announcement that raises the hope that this question will soon be settled to the satisfaction of both the public and the power company.

After considering a power project on the Pend O'Reille river in Northern Washington, the Secretary has laid down five conditions as "an ideal standard toward which to work in the making of the contract between the government and the applicants for the use of power." These conditions are:

1. The greater the development of horsepower, the lower charge per horsepower to be made on the part of the Government. This is intended to secure the full use of the stream.
2. The lower the rate to consumers the lower the charge on the part of the Government.
3. No charge whatever for a period of five or ten years during which the power company is finding its market.
4. Acceptance as a public utility of the State's jurisdiction over intrastate rates and service and of Federal jurisdiction over interstate rates and service.
5. Absolute prohibition of combination or monopoly and the right of revocation on the part of the Government in the event that it is established to the satisfaction of the Secretary of the Interior or the courts that such combination has been made or that prices have been fixed by agreement with competing plants.

The third condition, particularly, is one toward which engineers have been working for some years and if incorporated in the law will greatly encourage development. It must be remembered that these conditions are not yet law, merely being suggestive of the Department's attitude in interpreting existing law. Consequently criticism from us with regards to the indefiniteness of the several provisions is not now in order. It is merely a straw to show the wind's direction.

Another Transmission Record

The change of fashion in the design of electric power systems should be of particular interest to all engineers. Even those who most strenuously advocate standardization of all construction, with its resulting economy, must admit that change signifies progress. Every unique piece of construction should be studied so that its good points may be used to increase the efficiency of future plants. When all engineering work is so standardized that no improvement can be made, the industry will stagnate. Fortunately so many new situations requiring special design are so frequently arising that new styles must constantly be created to take care of them.

With these thoughts in mind much profit will follow a close study of the description of the system of the Southern Sierras Power Company published in the first two issues of this volume. The first deals with generation, the second with transmission and distribution. Yet another could be written on the commer-

cial utilization of this power by distant mines and irrigation plants—but that is another story.

As regards the power development, every endeavor has been made to fully utilize the limited amount of water available on the precipitous eastern scarp of the Sierra Nevada Mountains which rob the moisture from the highest clouds. Five plants are already pulling in tandem along the short course of Bishop Creek where a mile drop in elevation makes every drop of water count. The ultimate installation of two more plants and the complete development of storage capabilities will make this one of the world's most intensive utilizations of the power of falling water. The most noticeable feature in construction is the absence of open canal, ditch or tunnel. Gravity flow or pressure pipe not only conserves the water and keeps out snow and ice but also gives the benefit of regulation from the intake reservoirs. Few automatic regulating devices are necessary because of the constant water flow.

But the spectacular feature of the system is the transmission line. Two hundred and thirty-eight miles of uninterrupted transmission at one hundred and forty thousand volts sets a new record in commercial long-distance, high-tension practice. Steel-aluminum conductor is used throughout, special tower designs have been employed and out-door transformer stations are utilized. The data which the author has compiled on these several subjects is here published for the first time and should form a valuable reference for all contemplating similar installations.

Much of the material was "made to order" for this installation. Engineers may criticize this practice unless they consider the unique conditions which were to be met. The courage and common sense of a pioneer guides him in departing from the beaten path of precedent. While the special standards of this system could not be adopted as standard specifications for national use, they are peculiarly well suited for this particular system. All honor and credit should be given to the ability of the engineer who can determine when "circumstances alter cases" and devise new and better methods to meet such circumstances.

Blue Sky Legislation

A smokeless city, like a noiseless Fourth of July, is a matter of education. Persistent effort has finally forced many towns to prohibit fireworks. The record of the past week shows that as a result there have been fewer fires and deaths than ever before. While smoking chimneys have not exacted the same terrible death toll as exploding firecrackers, their cumulative damage to surrounding property and the involved fuel waste causes a much greater annual loss than may be ascribed to the celebration of the festive Fourth. Consequently anti-smoke ordinances are being enforced in many cities of the country.

No small part of the ninety per cent waste in fuel use is due to unnecessary smoke. By preventing even a small part of this loss we will benefit ourselves as well as our posterity, who will blame us more for our wasteful use of power than they will praise us for our conserving disuse. Scientific management of the power plant must begin with the improvement of fuel combustion.

Proper combustion means proper air supply. Hydrocarbons are volatile at temperatures far below their ignition point and without sufficient air they are liable to pass up the chimney unconsumed, or at least only partially combined as carbon monoxide, whose formation liberates less than one-third as much heat as does that of carbon dioxide. Furthermore, if the flame strikes the comparatively cold boiler tubes before its burden of hydrocarbon vapor is consumed, it is extinguished as it would be by the wire gauze of a miner's safety lamp. Passing on as dense black smoke it poisons the air and pollutes all that it touches. By enlarging the combustion chamber so as to interpose more space between the grate and the boiler the gases are burned before cooled and the smoke is minimized.

Too much air is almost as bad as too little as it carries up the stack the heat which would otherwise be imparted to the water. The evil effects of excess air are usually under-estimated. If the plant owner had to pay for his air as he does for his water he would caution the fireman to use less. But as the air costs nothing he continues blissfully ignorant that this free agent is regularly robbing the heat produced by at least one in every eight barrels of oil. Study of his fuel bill will show that there is nothing so expensive as what he gets for nothing.

A certain amount of smoke from a power plant is as unavoidable as fleas on a dog, especially with fluctuating load. Yet it is easy to calculate the correct amount of air to burn a fuel of known composition. Good practice allows an excess of fifty per cent over this theoretical amount. Many plants, however, are using an excess of two hundred per cent, or more. Reducing this spells fuel economy.

The amount of air being used may either be directly measured with an anenometer, the heat loss may be determined by a pyrometer or the air content be ascertained by an analysis of the flue gas, the last method being in most general use. The percentage of carbon dioxide is also a reliable index of the amount of air passing through the furnace. When the correct percentage has once been determined by an expert the fireman merely has to maintain it by adjusting his damper in accordance with the reading of some one of the mechanical carbon dioxide indicators that are on the market.

Smoke is not only an industrial waste but is also a legal nuisance. Any reasonable "blue sky" ordinance intended for its abatement will be sustained by the courts. When the dirt that it creates and the discomfort that it causes become intolerable, the sufferers are compelled to appeal to the lawyer for relief and drastic legislation frequently ensues. This may be obviated by a little care and foresight on the part of the stationary engineer if he will but anticipate this inevitable effort for civic betterment by drafting aud urging more reasonable laws.

The engineer should not leave to the lawyer and politician the regulation and even the operation of his plant.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLI ITED FROM ALL READERS

R. Wiley, superintendent of an electric power plant near Mexico City, is in San Francisco.

L. R. Boynton of the Central Electric Company, Los Angeles, was in San Francisco this week.

R. D. Holabird of Holabird Reynolds Company, San Francisco, is spending a vacation at Lake Tahoe, California.

C. W. Chalfant of the Los Angeles branch of the Pacific States Electric Company, was a visitor to San Francisco last week.

R. W. Turnbull, connected with the General Electric Company at Seattle is spending a few days in San Francisco.

C. F. Conn, electrical engineer of J. G. White & Company, has just returned from a business trip throughout the East.

C. L. Wernicke, Portland representative of the Westinghouse Electric & Manufacturing Company, spent a day in Seattle recently.

F. B. Uhrig, district manager of the Western Electric Company, Kansas City, arrived in San Francisco the latter part of the week.

F. N. Kollock Jr., district manager Westinghouse Electric & Manufacturing Company, Seattle, was in Portland some days ago on business.

A. L. Kempster, general superintendent of the Puget Sound Traction, Light & Power Company, has recently been made manager of the company.

L. Levy of the Levy Electric Company, San Francisco, is among those who have caught the vacation habit and is resting up at Lake Tahoe, Cal.

G. B. Harrington, assistant general superintendent of the Puget Sound Traction, Light & Power Company, has been made first assistant to the manager.

A. B. Martin, formerly employed on electrical work in Vancouver, B. C., has joined the sales force of the Pacific States Electric Company at Seattle.

J. F. NePage, of NePage, McKenny & Company, electrical engineers and contractors, Seattle, spent several days last week on a business trip to Portland.

J. P. Lottrige from the Portland office of the General Electric Company, was in Seattle last week making transfer of the company's stock from the warehouse of the Western Electric Company to 610 Railroad avenue

Thos. Collins of the sales department Westinghouse Electric & Manufacturing Company, San Francisco, has been confined to a sick bed several days. Physicians in attendance have prescribed a complete rest from business cares.

W. S. Hanbridge, secretary of the Electrical Contractors' Association, San Francisco, left Thursday for Chattanooga, Tenn., as delegate of the California Electrical Contractors' Association to the National Contractors' Convention, which meets in that city July 15th.

M. T. Crawford, superintendent of transmission Puget Sound Traction, Light & Power Company, has returned from the A. I. E. E. convention held at Cooperstown, N. Y. He also made a rather extended trip in viewing many of the transmission projects throughout the east.

W. P. Neville, who has been the freight and passenger agent for the Central California Traction Company in Sacramento for the last two years, has been appointed to the position of general agent. Neville will be in charge of the freight and passenger business for the entire line.

T. E. Bibbins, assistant general manager of the General Electric Company, San Francisco, has returned from an extended trip through the East during the course of which he attended the National Electric Light Association Convention at Chicago, and visited the Schenectady plant of the company.

F. S. Pratt, vice-president of the Stone & Webster Company, and **W. E. Herring,** industrial agent of the Puget Sound Traction, Light & Power Company, recently returned from an inspection trip extending as far north as the international boundary. Mr. Pratt departed for Boston July 8th.

G. B. Fairbanks, formerly salesman with the Westinghouse Manufacturing Company, Seattle, and assistant manager Chicago office, Fort Wayne Works of the General Electric Company, has joined forces with Colman & Hahn Electric Company, electrical contractors, at 1123 South A street, Tacoma.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

The Santa Barbara Gas & Electric Company has applied for authority to issue $100,000 in bonds for the purpose of extending and improving its system.

The San Joaquin Light & Power Company has filed an application for authority to issue $2,500,000 bonds, and to use them as collateral security for the issuance of $1,875,000 of two-year collateral trust notes. It is proposed to use the proceeds in making additions to the company's facilities.

Postponement until July 21 was made of the hearing of the application of the Oro Electric Corporation and the Oro Development Company to dispose of 1000 first mortgage 6 per cent gold bonds of a par value of $1000 each.

The commission has granted authority to the San Diego Consolidated Gas & Electric Company to issue $639,000 of its 5 per cent 30-year bonds. The money is to be used for the purpose of building plant additions.

The Great Western Power Company has been granted authority to operate under franchises previously given in Contra Costa county, particularly in the vicinity of Antioch.

Application of the Honey Lake Valley Mutual Telephone Association to issue promissory notes in the sum of $10,000 has been granted.

The Beaumont Gas & Power Company has been granted authority to issue a mortgage note in the sum of $5000 for the purpose of paying off existing indebtedness.

The application of W. L. Childers to lease the Crescent City Water Works to the Mountain Power Company, of Crescent City, Del Norte county, has been granted. The Mountain Power Company also takes an option to purchase.

Authority was granted to the Southern California Edison Company to issue 30,000 shares of its common capital stock of the par value of $100 per share. The company will offer 1000 shares to its own stockholders and a syndicate is being formed to underwrite the remaining 20,000 shares. The order of the commission provides that the stock shall be sold for not less than $80 per share. This is one of the largest issues of stock which the commission has authorized, and in making the authorization the commission states that it approves of this policy of selling stock to raise a portion of the money needed for capital expenditures. The commission approves the plan under which 75 per cent of the money for additions and betterments is to be raised from bonds and the remaining 25 per cent from stock.

TRADE NOTES.

Brayton Engineering Company, Portland, have received the contract for the Pittock Block. D. E. Lee will superintend the electrical installation.

The Gambrinus Brewing Company, Portland, have installed a 100 kilowatt, 220 volt, 3-phase General Electric generator direct connected to a Ball compound engine.

An order for over five thousand No. 6541 receptacles and plates has been placed with the Manhattan Electrical Supply Company for installation in the new municipal building in in New York City.

Buxbaum & Cooley, electrical engineers and contractors, Seattle, have the contract for installing a 7 kw. and a 2 kw. turbine generator set in the new Lake Washington ferry for lighting purposes.

The A. Z. Smith Electric Company, Tacoma, has completed the installation of a 90 foot span 350 foot timber crane and 5-ton hoist for the Pacific States Lumber Company at Sellick, Washington.

The Gas Consumers Supply Company, Tacoma, has secured contracts for equipping all of the kitchens in the Mottau apartments as well as the Wheeler apartments with Detroit Jewel cabinet gas ranges.

David Dow & Son, Seattle, recently installed for the Manhattan Construction Company all the electrical machinery for driving the mixers, hoists and saws being used in the construction of the Bryant and Concord school buildings.

Fairbanks, Morse & Company are furnishing the electrical equipment for a large refrigerating plant for the Rogue River Fruit Produce Association at Medford, Ore. One 50 horsepower motor, one 15 horsepower motor and two 40 kw. transformers will be installed.

The Greenwood Advertising Agency (Western) of Los Angeles, Cal., recently shipped a large electric sign to the Puget Sound Traction, Light & Power Company of Seattle. The sign filled an entire car. It is 200 ft. long and 56 ft. in height and is to be installed on their power plant at Dierinser, Wash.

The Reynolds Electric Company, Seattle, has sold a 2-ton electric hoist to the Alaska Steamship Company, same to be installed at Ketchikan, Alaska. A 50 h.p. motor and hoisting rigs were sold to the Ferro Concrete Construction Company to be shipped to Vancouver, B. C. A 17½ kw. lighting plant is also being installed for the Nipon Lumber Company at Nipon, Washington.

NEW CATALOGUES.

The Sprague Electric Works of General Electric Company has issued Catalog No. 521 describing Flexible Steel-Armored Hose for railroad service.

The William B. Pollock Company, Youngstown, Ohio, has issued an attractive folder illustrating the use of their steel penstocks in the Keokuk Development.

The Standard Underground Cable Company, Pittsburg, has issued Bulletin No. 700-1 giving descriptions of their "Outdoor Cable Terminals." A comprehensive index is appended.

"Electricity in the Manufacture of Jewelry," issued as Circular No. 3071 by the Holtzer-Cabot Electric Co., Boston and Chicago, describes many kinds of electric drive suitable for manufacturing jewelers. The booklet contains a variety of cuts illustrating the application of these devices.

A new publication on "Outdoor Cable Terminals" known as Bulletin No. 700-1 has been received from the Standard Underground Cable Company, Pittsburgh, Pa. This volume is 6 x 9 in. in size and contains 28 pages of condensed descriptive matter, illustrations and tables of dimensions, voltages, weights, etc., together with instructions for ordering and installing outdoor cable terminals. This bulletin is the first of a forthcoming series which is designed to supply its customers and prospective customers with such information as can be conveniently filed for reference. Copies will be sent to those interested upon request.

As a means of creating a desire for electric appliances, "The Silk Cord," published by Electric Development Association, Inc., of Boston, must surely be a success. The June issue especially is cleverly gotten up. Central stations contemplating publishing similar organs will do well to take a look at this example of a creator of desires.

The June issue of Edison Current Topics, published by the Southern California Edison Company, is one of the most truly electrical station organs published. The front cover, designed by Charles H. Pierson, depicts the spirit of light shedding her bounteous gift over Los Angeles, while the back cover shows the rugged mountains from which the source springs. Contributions by John B. Miller, Alan E. Morphy and S. M. Kennedy, together with many smaller personal items make this publication interesting to employes and consumers among whom it is circulated.

As a companion book to "Catechism on Direct Current Apparatus," Fairbanks, Morse & Co., of Chicago, have recently issued a Catechism on Alternating Current Apparatus. The booklet deals with the construction and application of generators, motors and auxiliary equipment in which the writer has succeeded in giving in a condensed question and answer form a great amount of practical information. A glossary covering all electrical terms used is included, which makes the book of considerable value to the non-technical man. Copies will be sent to interested parties on request to the Chicago office of the company.

BOOK REVIEWS.

Water-Supply Paper 314. Surface Water Supply of Seward Peninsula, Alaska. By F. F. Henshaw and G. L. Parker; with a sketch of the geography and geology by P. S. Smith and a description of methods of placer mining by A. H. Brooks. 1913. 317 pages; 17 plates; 12 text figures.

Presents in detail the results of stream-flow measurements made in Seward Peninsula during the years 1906 to 1910, inclusive. The geography and geology of the peninsula are first briefly described, inasmuch as they have a controlling influence on the run-off, and the occurrence and distribution of the gold placers are summarized in the section devoted to geology. At present the mining of the placer gold is the only incentive to the utilization of the stream-flow. Methods and costs of mining are also briefly considered. The illustrations include topographic and geologic maps of Seward Peninsula and plates showing methods of hydraulic mining.

Resuscitation. By Dr. Chas. A. Lauffer, Medical Director, Westinghouse Electric and Manufacturing Company. Size, 4¼ x 6½ inches; 7 illustrations; cloth binding. Published by John Wiley & Sons, and for sale by Technical Publishing Company, Rialto Bldg., San Francisco. Price, 50 cents.

This book includes a reprint of a paper on this subject delivered by the author before the Philadelphia Section of the National Electric Light Association. The author, after explaining a number of successful results which have been obtained from employing resuscitation methods on men who were supposedly dead, gives a clear description of the mechanism of respiration, illustrating same by a number of views of the various parts of the anatomy.

This book brings out in a clear, concise manner the necessity of people in general being versed in the principles of resuscitation, and clearly shows how they can be taught so as to prove of valuable assistance to persons in the ordinary walks of life.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

NEW ELECTRICAL ORDINANCE.

The following ordinance affecting Electrical Contractors has been passed by the Board of Supervisors of San Francisco:

AN ORDINANCE REGULATING THE INSTALLATION, CONSTRUCTION, OPERATION AND INSPECTING OF ELECTRICAL WIRES, APPLIANCES AND APPARATUS, IN OR ABOUT BUILDINGS OR OTHER STRUCTURES IN THE CITY AND COUNTY OF SAN FRANCISCO, FIXING A STANDARD THEREFOR, PROVIDING FOR THE GRANTING OF PERMITS TO MASTER ELECTRICIANS AND FOR THE REVOCATION THEREOF; AND PROVIDING FOR THE CONDEMNATION OF ELECTRICAL WORK OR INSTALLATION OF APPARATUS NOT IN CONFORMITY HEREWITH AND FORBIDDING THE FURNISHING OF ELECTRICAL CURRENT TO SAID CONDEMNED ELECTRICAL INSTALLATION AND FIXING PENALTIES THEREFOR, AND REPEALING ALL ORDINANCES IN CONFLICT HEREWITH.

Be it ordained by the People of the City and County of San Francisco as follows:

Section A. Every person, firm or corporation engaged in the business of placing, installing, erecting or contracting to place, install or erect any electrical wires, appliances, apparatus or construction in or on buildings or other structures shall, before commencing or performing any such work pay such license fee as may be prescribed by ordinance and appear in person, or by duly authorized agent, at the office of the Department of Electricity and upon presentation of his said license be entitled to the registration of his or their name and place of business in the said city and county of San Francisco as a Master Electrician, and to a permit from said Department of Electricity to engage in the business of Master Electrician in said city and county; provided, that no such permit shall be granted for a longer period than the date of expiration of aforesaid license.

Sec. B. Every person, firm or corporation shall, before placing, installing or erecting any electrical wires, appliances, apparatus or conductors, or to electrically connect any electrical wires or conductors, together or to any electrical machinery, in or on buildings or other structures, file with the Department of Electricity a written application for a permit to proceed with such work, the aforesaid application for permit shall be accompanied by a brief specification showing the kind and nature of the proposed electrical apparatus, wires, appliances or construction and the location and description of the premises wherein the work is to be performed. Said permit shall be conspicuously posted on the premises wherein said electrical work is being installed. Provided, however, that no such permit to proceed with such work shall be issued by the Department of Electricity to any person, firm, corporation, or individual that has not received a permit to do business as a Master Electrician in conformity with the terms of this ordinance.

Sec. C. It shall be unlawful to conceal or cause to be concealed, any wires, apparatus, appliances or construction in or on any buildings or other structures before same has been inspected by the Chief of the Department of Electricity, or his authorized representative, and his approval posted on the building or other structure wherein same is installed.

Sec. D. Every person, firm or corporation placing, installing, erecting any electrical wires, appliances, apparatus or construction, or electrically connecting any electrical wires or conductors together, or to any electrical machinery, in or on buildings or other structures, shall notify the Chief of the Department of Electricity when same is completed. The Chief of the Department of Electricity or his authorized representative, shall at once inspect the same, and if in compliance with all ordinances, shall issue to the said person, firm or corporation a certificate of approval. Said certificate shall contain the date of final inspection and in concise terms specify the electrical wires, appliances, apparatus or construction thus approved.

Sec. E. The failure, neglect or refusal on the part of any person, firm or corporation, for the period of ten days after receipt of a notification so to do in writing, by the Chief of the Department of Electricity, to correct, obviate or remove any fault, error or deficiency in placing, installing, erecting any electrical wires, appliances, apparatus or construction, or in electrically connecting any electric wires or conductors together or to any electrical machinery, appliances, apparatus or fixtures in or on any building or structure in the city and county of San Francisco to conform with the provisions of all ordinances of this city and county and in all other respects to conform with the best known general standards existing at such time shall be deemed sufficient cause for the Chief of the Department of Electricity to revoke the offending party's permit to transact the business of Master Electrician until such faults, errors or deficiencies are corrected, as hereinabove set forth.

Sec. F. Any corporation, co-partnership, association or individual, or agent thereof, owning, operating or in the possession of any building or other structure within the limits of the city and county of San Francisco, shall permit the Inspector of the Department of Electricity to enter such or premises as often as shall be deemed necessary by the Chief of the Department of Electricity for the purpose of inspecting the electrical wiring appliances, apparatus, construction or equipment in or about said plant, building or other structure and it shall be unlawful for any occupant or owner of premises where any electrical wires, apparatus, appliances, construction or equipment are used, or any person whatever, to prevent or interfere with any Inspector in the discharge of his duties under this ordinance; provided, however, that the said Inspector shall, upon the request of the owner or occupant of said premises, exhibit his authority to make such inspection, which shall be signed by the Chief of the Department of Electricity. Should the Chief of the Department of Electricity or any inspector thereof find the installation of any electrical wiring apparatus, appliances, construction or equipment to be defective or not in accordance with the provisions of any ordinance or the standards fixed herein, the same shall be condemned and the use threof forbidden until the same be corrected; upon the failure of any corporation, co-partnership, association, individual or agent thereof owning or leasing any building or structure in the city and county of San Francisco to correct such defective and condemned electrical wiring apparatus, appliances, construction or equipment, for a period of six days after the receipt of notice in writing from the Chief of the Department of Electricity so to do, which notice shall specify in detail the connecting to be made, the said Chief of the Department of Electricity shall forthwith direct the corporation, co-partnership, association or individual, or agent thereof, supplying the electrical power for said connection, to disconnect the same, and it shall be unlawful for any corporation, co-partnership, association or individual, or agent thereof, furnishing electrical current, to furnish or renew said power supply without permission from the Chief of the Department of Electricity.

(To be continued.)

INDUSTRIAL

ELECTRIC HALF-TONES.

The accompanying illustrations show a recent development in electric signs which has been perfected by the Greenwood Advertising Agency.

Heretofore the bringing out of features or faces electrically has been unsatisfactory but by this method faces can be brought out in silhouette and by proper manipulation

Electric Half-tone of George Washington.

Two Views of a Changing Half-tone.

of the lights different expressions can be obtained. The idea is the same as cartoonists use for daylight effects, but has never before been aplied to night displays. As a means of bringing into greater prominence convention leaders and political candidates, this novel device will add to the attractiveness of the "Great White Ways" and expositions of the future. The changing face shown here is one that is being erected in Los Angeles.

MANUFACTURING IN A FLOWER GARDEN.

Commuters on the Montclair Branch of the Delaware, Lackawanna & Western Railroad are treated to a very attractive demonstration of the fact that a manufacturing plant need not necessarily be an eyesore and a blot on the landscape. Twice a day, as their trains have passed the station at Ampere, N. J., they have caught a glimpse of a group of neat and orderly factory buildings, set amid twenty-five acres of well kept lawns, flower beds, shrubbery and big shade trees, and all surrounded by a half-mile girdle of pink rambler roses in full bloom.

The attractive appearance of this industrial plant, which is owned and operated by the Crocker-Wheeler Company, manufacturers of electrical machinery, is an interesting commentary on the present attitude of most progressive corporations toward the general public. This particular company evidently regards it as a duty to the community as well as to itself to have its works present a clean orderly aspect, and even an attractive one, so far as this is possible in a manufacturing establishment.

USES OF STORAGE BATTERIES.

The remarkable accomplishments of electricity are too well known to require comment, but many readers do not appreciate the part that has been played by storage batteries in the development and use of electrical apparatus.

This month, the Crocker Land Expedition under the auspices of the American Museum of Natural History, the American Geographical Society, the University of Illinois and other institutions, will sail from New York City to explore the North Polar regions.

One of the interesting features of this expedition's equipment will be a complete electric lighting plant, which will be installed in a portable house at about 80 deg. north latitude. This lighting plant will be equipped with an "Ironclad-Exide" Battery, so that electric lights will be available at all times, and it will only be necessary to run a kerosene engine occasionally to charge the battery. The electrical apparatus of this expedition will be in charge of Ensign Fitzhugh Green, U. S. N.

This battery will be composed of 20 trays weighing 1720 pounds and having sufficient electrical capacity to light 115 eight candlepower lamps for ten hours.

The digging of the Panama Canal, which is to be opened this fall, has been done largely by electrical machinery in connection with which storage batteries have been used. The batteries chosen by United States Government engineers for this service have been of the type known as the "Chloride Accumulator," and even at the high temperatures experienced in this tropical region have given most satisfactory service. These facts demonstrate that storage batteries of the proper types will operate satisfactorily in either very cold or very warm climates. The "Chloride Accumulator" is also used in connection with wireless apparatus and for electric lighting and power service.

The United States Government in its various departments has extensively studied and experimented with storage batteries and utilizes them for numerous purposes. Submarine boats of the navy, when submerged, are propelled through the water by current furnished from storage batteries. War ships use storage batteries for firing large guns and depend upon them for the emergency operation of wireless apparatus. Vessels of the navy as well as fortifications on land are provided with storage batteries as an emergency outfit for furnishing electric lights. In the Postoffice Service and at many navy yards the Government uses electric motor cars propelled by storage batteries.

Storage batteries are constantly finding many new and popular used, such as for starting and lighting automobiles, and, therefore, a little storage battery knowledge is well worth while.

The Electric Storage Battery Company is one with a service organization extending throughout the country, at the disposal of storage battery users, and it is the desire of the company to consult with and help any one who uses storage batteries for any purpose.

NEWS NOTES

INCORPORATIONS.

LOS ANGELES, CAL.—Madera Gas Company; capital stock, $75,000; L. R. Kurtz, P. T. Moses and H. L. Decker, directors.

ILLUMINATION.

NEEDLES, CAL.—The Needles Gas & Electric Company was the only bidder for lighting the town of Needles.

LONG BEACH, CAL.—The city council has adopted specifications for installing and equipping ornamental lighting standards in this city.

MONROVIA, CAL.—Extensive improvements have begun on the plant of the Southern Counties Gas Company. The total cost of machinery, which will be installed by the Baker Iron Works, is estimated at $80,000.

ORANGE, CAL.—The Pacific Light & Power Corporation has been granted a franchise to operate for a period of 50 years for transmitting electric power for lighting, heating and power purposes, in Orange county.

SEATTLE, WASH.—The Puget Sound Traction Light & Power Company has made application to the King county commissioners for three lighting franchises, one in North Seattle, one in Kirkland and the other in Redmond.

BERKELEY, CAL.—At a meeting of the City Council this week the Great Western Power Company made formal request for a 35-year franchise to transact its light and power business in this city. It is reported that the city officials favor the granting of the franchise.

TACOMA, WASH.—The electrically equipped planing mill of the St. Paul and Tacoma Lumber Company is ready for operation. The 1000 kw. turbo-generator to be used in operating the planing mill and furnishing light and power for the plant generally has arrived and will be put in operation shortly.

OAKLAND, CAL.—Geo. E. Babcock, city electrician, after a conference with Fred C. Turner, commissioner of public health and safety, has evolved a plan gradually to install a municipal system of street lighting, by which the city will own the poles, wires, lights and other equipment. The plan provides that the city will put in the street lighting system district by district until the municipal lines extend over the entire city.

SEATTLE, WASH.—The City Council of Seattle has adopted a resolution which has been referred to the Corporation Council, requesting that the State Public Service Commission appraise the property of the Seattle Lighting Company, investigate its rates, its charges for gas and its practices, with a view to rate reduction and adjustment of grievances. The former engineer of the Commission estimated the value of the plant for rate-making purposes at $6,000,000.

SEATTLE, WASH.—The supreme court of Washington recently held that the Puget Sound Traction, Light & Power Company be required to pay an assessment of $3822 for regrading the Harrison street district in Seattle. In the condemnation proceedings to determine damage to property in the district by reason of a regrade, the company was awarded $5000 damages. On the ground that the award for damages in the condemnation proceedings released it from the assessment, the company refused to pay.

ANAHEIM, CAL.—Natural gas brought to Los Angeles from Midway is to be supplemented by a supply from the fields in and around La Habra Valley. The Southern California Gas Company has secured 5,000,000 cu. ft. of natural gas, produced daily by the oil wells of the Amalgamated Oil Company, and whatever amount may be added to this by development. The plans call for an 8-inch pipe line to Los Angeles and compressor station in the field to furnish motor power to transmit gas a distance of 20 miles.

VANCOUVER, B. C.—Proposals have been submitted by the British Columbia Gas Company, for the approval of the Vancouver city engineer, for constructing a new gas-generating plant in Hastings Townsite, Vancouver, at an estimated cost of $1,500,000, and covering about seven acres. The first unit will cost $150,000, which it is expected will be ample for five years, after which another $500,000 unit will be constructed, suffiicent for ten years. Subsequently a third $250,000 unit will be built. Work on the first unit will start as soon as permission is received, and it is thought will be completed within twelve or fifteen months.

TRANSMISSION.

LONG BEACH, CAL.—A building permit has been issued to the Southern California Edison Company for the first unit of its plant to be erected on the west side of the harbor. The unit is to cost $288000, and is to be class A, reinforced concrete construction. Work will begin in 30 days.

VANCOUVER, B. C.—Anticipating the future requirements of Greater Vancouver and the probability of the electrification of the coast section of the Pacific Great Eastern Railway, the Bridge River Company, recently incorporated, plans to develop at least 200,000 horsepower in the Lillocat District. The expenditure involved will be about $3,000,000. The project calls for the building of a large dam on the Bridge River and a tunnel two and one-half miles long through a mountain on Seaton Lake.

SAN FRANCISCO, CAL.—The directors of the Pacific Gas & Electric Company decided to pass the dividend usually declared upon the common stock of the company as of July 15. In announcing the decision of the directors, John A. Britton, vice-president and general manager of the company, said that while the company has arranged for the financing of all big development work now under way or contemplated, it was deemed advisable that the company should do its part by postponing a dividend on the common stock at this time in order to make future dividends more certain. The Lake Spaulding project, he pointed out, will result in a large saving in cost of production, and the directors thought it good business to devote all available resources to the early completion of this work.

SEATTLE, WASH.—The Seattle Port Commission is calling for bids to be opened July 23rd on the mechanical equipment of the Smith Cove dock, to be used in handling lumber and heavy commodities generally. Equipment called for is in three units. A is a Geantry crane for serving an open lumber wharf 900 ft. long, the crane to have a working span of 175 ft. and to be operated entirely by electricity. B is a monorail system for handling lumber in a dry lumber shed 100 x 600 ft in length. Two electrically operated trolleys will be installed. C is a locomotive crane provided for general use at the dock and to serve the section not reached by the Geantry crane. The crane called for will be 10-ton capacity and will be of standard gauge, so that it can operate on the railway tracks and can be utilized to some extent in the moving of cars. The whole equipment is designed to be equal to the latest and best practices by the largest lumber manufacturing concerns in the country.

TRANSPORTATION.

EUGENE, ORE.—A franchise has been granted the Portland, Eugene & Eastern Railway in this city.

ANACORTES, WASH.—An application has been filed by Geo. W. Krebs for a franchise for a street railway covering all the main streets of the city.

TULARE, CAL.—Grading of the Big Four Railroad from Tulare to Poplar, a distance of 21 miles has been completed and it is stated that laying of steel will be started at once. Contracts for the rails have been let with an Eastern firm.

SEATTLE, WASH.—A tentative offer has been made to the Seattle city council by Scott C. Calhoun, one of the receivers of the Seattle, Renton & Southern street railway, to sell that portion lying within the city limits for $1,200,000. The offer is being investigated and the question of buying the entire line is also being given consideration. The line is 9 miles long.

SAN FRANCISCO, CAL.—The supervisors have fixed the date of the bond election for the extension of the municipal street railway system to the exposition grounds, for Tuesday, August 26. The board also adopted a resolution providing for the holding of a conference between the city and the harbor commissioners on the best plan for the improvement of the present terminal facilities at the foot of Market street.

TACOMA, WASH.—Judge Easterday of the Pierce County, Washington, superior court, has sustained the contention of Tacoma revoking the Tacoma Railway & Power Company franchise on the ground that it has violated its franchise by selling current for lighting purposes. The company has appealed and the case will be heard by the supreme court in October. Action is being started against the Seattle & Tacoma Power Company on the same grounds.

SEATTLE, WASH.—The city council of Seattle has accepted the Highland Park & Lake Burien Street Railway line with a view of operating it in connection with the municipal system now under construction. The line extends from West Spokane avenue to Lake Burien, a distance of about 9 miles, approximately one-half of it being in the city. With the extensions contemplated by the city the line will be about 12 miles long. That portion of the road within the city limits is a gift to the city. It is estimated that $12,000 will be required to put it in shape for operations.

LOS ANGELES, CAL.—Following a series of conferences an agreement has been reached between S. M. Haskins, an attorney, representing the Los Angeles Railway Corporation, and property owners in the southwest part of the city in regard to the proposed opening of Hoover streets, through the shoestring strip to the harbor. The street railway company offers to deed to the city property valued at $250,000 for the thoroughfare on condition that it be given the right to change from steam to electricity for motive power on the old Los Angeles and Redondo line over the land in question.

SACRAMENTO, CAL.—An ordinance opening the way for the entrance to Sacramento of all electric lines over the rails of the Northern Electric has been passed by the city commission. The ordinance also calls for the transfer of the Northern Electric tracks on Front street to Second from M to X. The franchise granted to the Northern Electric formerly provided that two additional franchises over the same rails might be granted providing the railroad lines to come shared the expenses of construction with the original grantee. The new ordinance wipes out the restriction to three lines and makes the city commission the sole judge of how many franchises shall be granted over the same rails. The Northern Electric gave up this right in consideration of permission from the city to transfer its tracks from Front to Second street. The trackage affected by the Northern Electric's abandonment of the exclusive feature of the old franchise is approximately six miles in length.

TELEPHONE AND TELEGRAPH.

SO. PASADENA, CAL.—A franchise for 40 years has been granted to the Home Telephone Company and work will begin in a few days on laying of cable.

SEATTLE, WASH.—The application of B. H. Carter and the Pioneer Farmers' Telephone Company for a permit to erect and maintain a telephone pole line on country roads Nos. 507 and 830 was granted.

WATERWORKS.

AUBURN, WASH.—The city council will submit to the people the question of voting bonds in the sum of $10,000 for the construction of a water system.

ESCONDIDO, CAL.—Bonds in the sum of $100,000 for installation of a municipal water plant were ordered at a recent election. The bonds will be placed on the market at once.

HEALDSBURG, CAL.—The purchase of the pumping plant for the water system has been referred to the water and light committee, which will employ a consulting engineer to examine the plant and prepare plans and specifications for the new equipment.

PUYALLUP, WASH.—This city will have a better water supply as soon as the city council can take action on the plans submitted by the city engineer. The proposition is to buy Maplewood Springs, which will cost $29,746, and to utilize the one acre they own and install a pumping plant.

SAN FERNANDO, CAL.—The purchase of the water system of the Maclay Rancho Water Company by the city is recommended by a special committee of the Chamber of Commerce. The plant is owned by the Consolidated Securities Company of Los Angeles, which recently offered to sell it to the city for $50,000.

PORTLAND, ORE.—Both the 24 and 20-inch submerged Bull Run water mains across the Willamette will be lowered this summer to permt the dredgng of the upper harbor south of the Hawthorn bridge by the government. A contract for the work has been let to A. O. U. Berry for the sum of $69,400, the entire amount to be paid in city water bonds at 93 cents on the dollar.

LOS ANGELES, CAL.—The Sentinel Heights Water Company has started operations with paid-in capital of $1,000,000 and with $1,000,000 of bonds ready to be issued. The company is prepared to furnish water to 50,000 or more users on lots of the Los Angeles Investment Company in its several tracts southwest of the city. There are four wells on the property. The supply available is estimated at 10,000 or more miners' inches.

SACRAMENTO, CAL.—The Sacramento River as a future water source for Sacramento is recommended by the Chamber of Commerce water committee. The committee recommends that the chamber at once take steps to have the city secure an option on 40 acres of land north of the city as a site for the filtration plant, and urges the placing before the people of a proposition to vote $1,000,000 bonds for the plant. The actual cost of the plant is figured at $828,000.

SAN RAFAEL, CAL.—The directors of the municipal water district of Southern Marin have adopted a resolution authorizing negotiations for securing 5300 acres of the Howard-Shafter ranch as a site for the proposed municipal water plant and rights of way for pipe lines through the lands of the Marin Water & Power Company. George H. Harlan, attorney for the board, was instructed to prepare a resolution authorizing the district to open negotiations with the Marin Water Company and the North Coast Company for the purchase of those plants.

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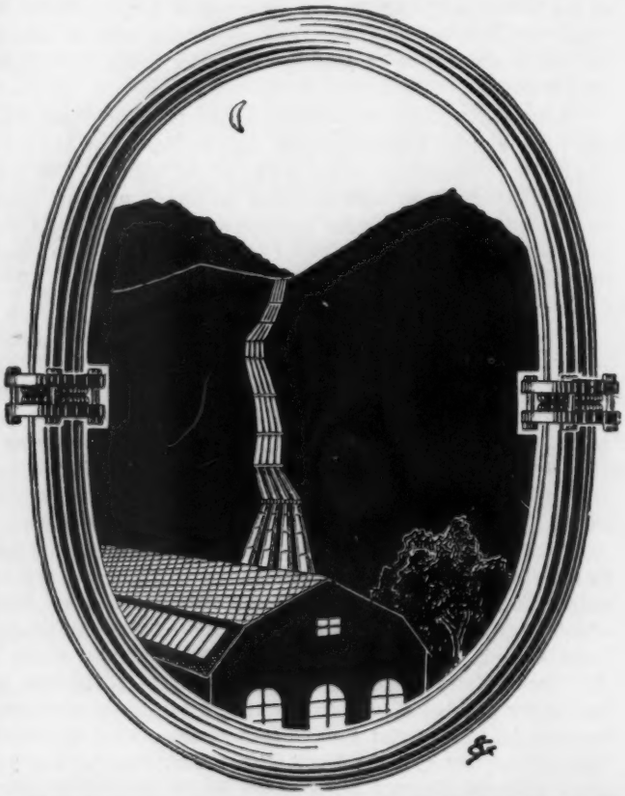
MANNESMANNRÖHREN-WERKE

DÜSSELDORF (GERMANY)



CONSTRUCTORS

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MAKERS OF

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